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JOURNAL

Progress Committee Report • Charles R. Daily 225

Water Flow Rates in Immersion-Washing of Motion-Picture Film • Samuel R. Goldwasser 248

Evaluation and Reactions: New Processes of Motion-Picture Presentation • Lucien E. Pope and Richard H. Orear 254

A System for Automatic Additive Printing and Scene Testing of Color Film • Frank P. Herrnfeld 256

A New Projection Lens • W. Lotmar and R. Stettler 259

Proposed SMPTE Recommended Practice 260

American Standards 260

Letter to the Editor 264

Contents continued on inside back cover

78th SMPTE Convention • October 2–7 • Lake Placid Club, Essex Co., N. Y.

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Progress Committee Report

By CHARLES R. DAILY
Committee Chairman

CONTENTS

Introduction 225
Set Lighting 238
uction Materials . 238
ment—Miscellane-
. 238
ography. 238
hotography . . . 238
nd Projection . . 238
sting—Equipment
ls. 239
. 240
ickup Equipment. 240
. 241
-See" TV 243
otography 243
. 243
ning—Foreign . . 243
hotography . . . 244
. 245
. 246
ee. 246
. 246

VY

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CONTENTS

Introduction 225
Wide-Screen Installations . . . 225
VistaVision 225
CinemaScope 226
Cinerama 228
Todd-AO 228
Theater Sound Equipment. . . 228
Drive-Ins 229
Projection 229
Background Projection 231
Cameras 231
Optical Equipment 231
Optical Printing 233
Sound 233
Perspecta Sound 234
Magnetic Recording and Striping 234
Black-and-White Film 235
Color Film 235
Film Processing and Printing. . 236
Measuring Instruments 237
Set Lighting 238
Studio Construction Materials . 238
Studio Equipment—Miscellaneous 238
Scientific Photography. 238
Stereoscopic Photography . . . 238
16mm Prints and Projection . . 238
TV Broadcasting—Equipment and Methods. 239
Projection TV 240
TV Remote Pickup Equipment. 240
TV Networks. 241
"Pay-As-You-See" TV 243
Electronic Photography 243
Eurovision 243
TV Programming—Foreign . . 243
High-Speed Photography . . . 244
Armed Forces 245
Conclusion 246
The Committee. 246
References 246

Introduction

The year 1954 was one of continued rapid change and progress for both motion pictures and television. CinemaScope became well established worldwide; more theaters were opened for the showing of Cinerama; VistaVision double-frame photography and projection were introduced by Paramount; thousands of additional theaters installed larger screens; many new drive-in theaters were constructed, and many of the older ones replaced small-screen towers with much larger ones. Stereophonic sound installations were installed by the thousands; the Perspecta sound stereophonic system was introduced both here and abroad; Todd-AO photographed *Oklahoma* with their 65mm negative system, and theaters installed larger lamphouses, better lenses and improved screens.

The television industry expanded, color broadcasting being introduced on a commercial scale and complete color studio facilities being installed in many stations; the vidicon tube was being adopted for both monochrome and color; the use of flying-spot scanners increased; improved zoom lenses were introduced; kinescope recording improved in quality, both for black-and-white and color; the International Telemeter experiments continued in California; high-quality sub-carrier sound diplexing equipments were introduced; additional VHF and UHF transmitters and many higher powered transmitters were installed; remote-pickup microwave relay equipment improved, and projection TV was profitable. Network TV broadcasting was extended to about 360 stations in more than 230 cities, with about 20,000 channel-miles of TV facilities in operation. Eurovision linked eight countries in Europe for the exchange of TV programs, and installations were rapidly increasing in all these countries and Canada.

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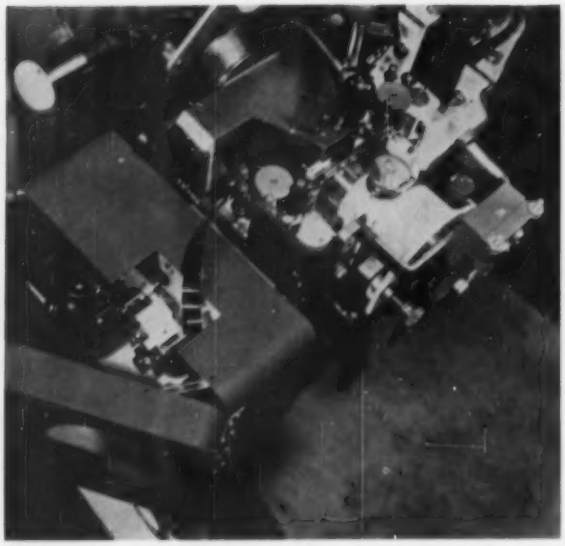

Fig. 1. Century double-frame VistaVision projector: top view.

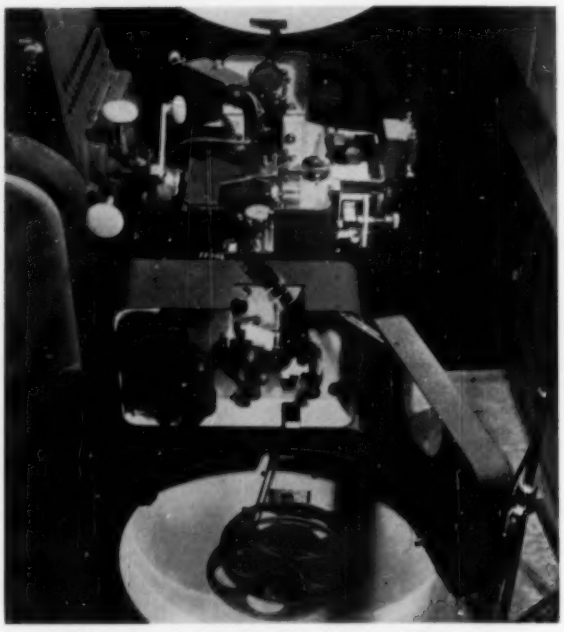

Fig. 2. Century double-frame VistaVision projector: side view.

on order. Double-frame projection uses an area of 1.4180 × 0.7225 in. for a 1.96 : 1 aspect ratio picture. This large area, when projected with high-grade standard projection lenses, provides a high-resolution, high-definition picture which is particularly noticeable on screens wider than 40 ft. The dimensions of the double-frame release print are shown in Fig. 3.

Technicolor has made marked improvements in the quality of the reduced VistaVision imbibition release prints that are intended for exhibition in any theater in the world. Perspecta sound has been used on all Paramount VistaVision releases.

Seven of the Mitchell VistaVision double-frame cameras were delivered, and 16 more were on order. These cameras are completely new in design and incorporate 2000 ft vertical magazines, laterally placed, and a monitoring finder with no lateral parallax and a minimum of vertical parallax. They operate in lightweight cast-magnesium soundproof blimps (see Figs. 4 and 5). Fourteen Technicolor cameras and blimps were converted to VistaVision operation—10 in Hollywood and 4 in England. Six of the original converted VistaVision Stein cameras and blimps are in use. New camera gearheads were designed and fabricated to accommodate the new shape and configuration of the Mitchell VistaVision camera.

CinemaScope

Industry acceptance of CinemaScope during the year was nearly universal in the United States. Thirty-five feature productions and approximately 40 short subjects were released; the total release of film footage with magnetic stereophonic soundtracks was over 100 million feet. Productions in CinemaScope were made by Twentieth Century-Fox, Warner Bros. Pictures, Metro-Goldwyn-Mayer, Universal-International, Columbia Pictures, Disney and a number of independent producers. Additional magnetic striping equipment was installed so that by December 31 the following were able to produce release prints; Warner Bros. Pictures, Metro-Goldwyn-Mayer, Columbia Pictures, Universal-International, General Film Laboratories, DeLuxe Laboratories (New York), and Twentieth Century-Fox. An engineering analysis of the design of the new CinemaScope film was presented.[3]

New optical camera systems for CinemaScope were developed and supplied in June 1954 by Bausch & Lomb. These systems combined the functions of the prime objective camera lens and the anamorphic unit, resulting in improved optical resolution. Simplification of adjustment for objective distance was achieved by combining objective lens focusing and anastigmatism correction on a single control. By year's end, 40mm and 50mm systems were in general use and 35mm, 75mm and 10mm versions were in production test. The new lenses have great flatness of field and less distortion at the side of the image. With the combination lens, one assistant cameraman can very easily control the effects, eliminating the possibility of errors, whereas formerly one man focused the objective lens and another man focused the anamorphic lens.

Theater installations grew rapidly, ending the year with a total of 10,355 in the United States and Canada and approximately 4000 in foreign countries.

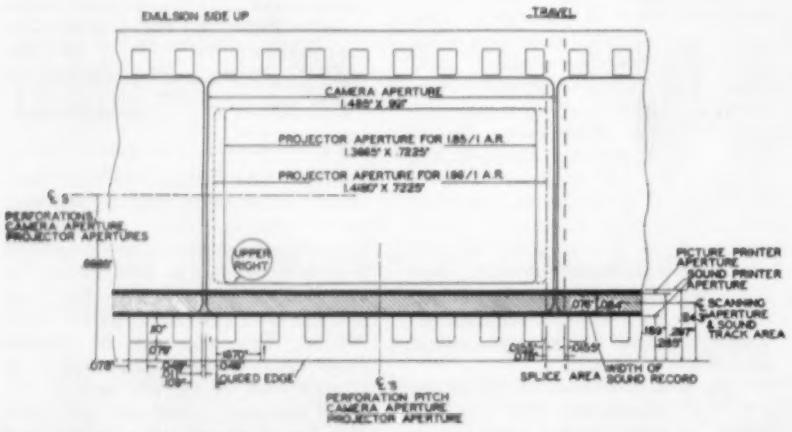

Fig. 3. Standard VistaVision double-frame print dimensions. (Final position of soundtrack will be moved slightly to accommodate projection shoes adjacent to picture.)

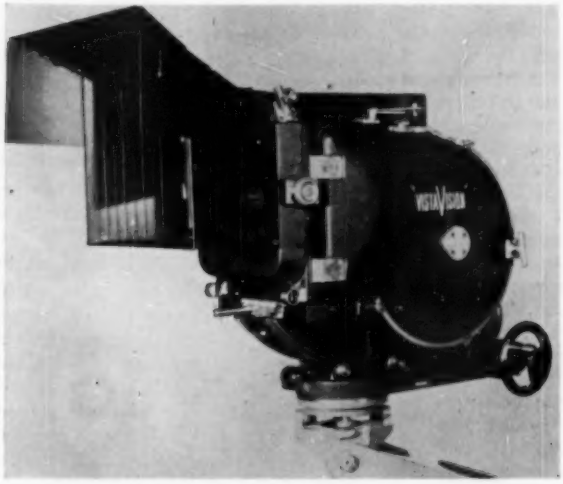

Fig. 4. Mitchell double-frame VistaVision camera, blimp; and gearhead.

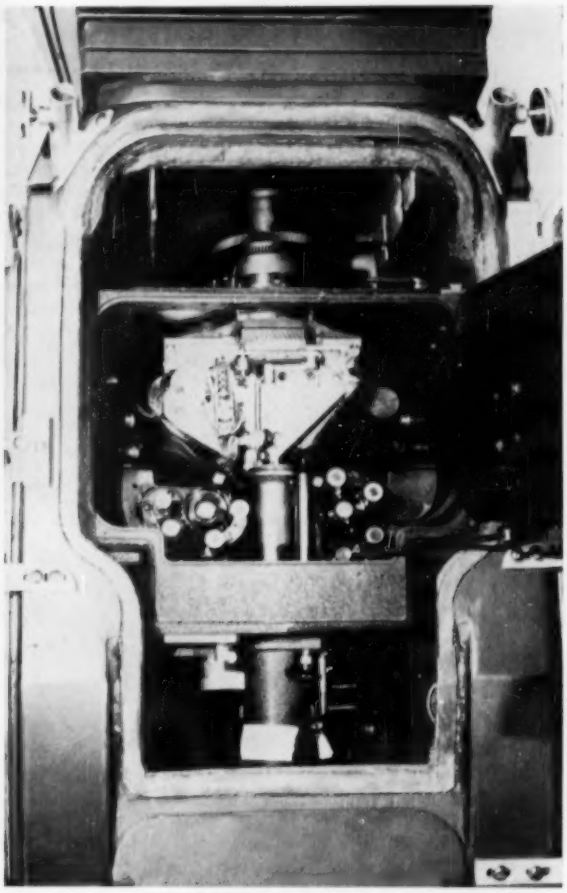

Fig. 5. Mitchell double-frame VistaVision camera and blimp; top view from operator's position with camera open.

Fig. 6. Westrex standard sound systems 38 amplifier cabinet.

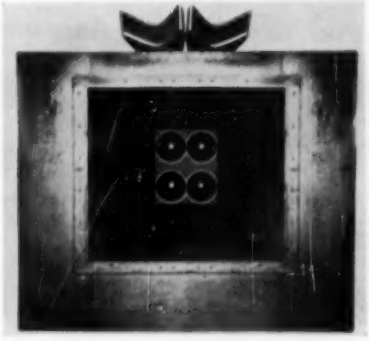

Fig. 7. Westrex T502B loudspeaker assembly with two 80° high-frequency acoustic lenses.

This total includes 4100 installations for magnetic sound reproduction in the United States and Canada and approximately 2000 foreign theaters similarly equipped; the remainder of the installations used optical sound reproduction. In Germany at the end of 1954 approximately 20%, i.e. 800 theaters, had converted to CinemaScope.

Bell & Howell introduced a new series of CinemaScope theater projection lenses. The Delrama anamorphic mirror system for use on cameras and projectors was developed by the Oude Delft Optical Co. in Delft, The Netherlands. The Arriflex camera has been modified to permit CinemaScope lenses to be mounted as an integral part of the camera. The aperture and sprockets are appropriately changed.[4]

16mm CinemaScope. Bell & Howell introduced the Filmorama system of shooting CinemaScope-type pictures on 16mm film. The camera lens can also be used for 16mm projection. The film may be blown up to 35mm for release on standard CinemaScope theater equipment. The 16mm film when projected is of normal balance and has an aspect ratio of 2.68 : 1.[5]

Printers. The Warner Bros. CinemaScope release printer comprises 2 master reproducers and 5 release printers, and a control console. In an 8-hr day 200,000 ft of release can be printed. Two complete Reeves striping applicators are used and an automatic film waxer is added. In re-recording, a single speech track can be switched to the left, center- or right-track position by a film that utilizes notches on both sides. Speech re-recording dummies will reproduce any two of the following three soundtracks: photographic track, single-magnetic track or triple-magnetic track. Rolls containing 2000 ft of magnetic film can be completely erased in a new automatic eraser.

Cinerama

The expansion of Cinerama continued throughout 1954, and more theaters were equipped for this type of projection. The second feature film, *Cinerama Holiday*, was completed and will soon be released.

Four Cinerama cameras now available have interchangeable assemblies and a registered accuracy better than that of standard motion pictures. Lens speeds have been increased from *f*/4.5 to *f*/2.8.

New projection equipment has been designed with standardized interchangeable assemblies and registered accuracy higher than that of the best printers available.

A new 7-channel magnetic stereophonic theater sound system which is now in use eliminates hum. Each channel has a power output of 60 w at less than 0.3% distortion and peak power of 90 w at less than 2% distortion. Sound recording in the field is now done with a special 7-channel system, and new microphone placement and recording techniques have been worked out for its effective use. A signal-to-noise ratio of at least 57 db has been obtained with track widths of 0.047 in. All units of both recordings and theater equipments are interchangeable. Five dubbers are used, each equipped with a 7-track head, and the new type of mixing console has 2 channels of 7 tracks each.

Editing is done with 8000-ft reels, 30½ in. in diameter, with film traveling 146.25 ft/sec. Special Moviolas have been built to handle the 7-track magnetic film. Special film-testing equipment has been built to automatically reject film that does not show satisfactory uniformity. Erasing is done in 9000 ft reels in a special machine.

Todd-AO

The first Todd-AO production, *Oklahoma* was photographed in 1954 and will be released in 1955. This system uses a single 65mm width negative with a new-type perforation which provides 53mm clear space between the perforations. The negative picture is 5 sprocket holes high, running at 30 frames/sec (approximately 140 ft/min). The 2 : 1 aspect ratio provides a negative film area approximately 3½ times the area of standard 35mm film. The release prints are made on 70mm film to accommodate the high-fidelity stereophonic sound system which will probably use 6 soundtracks plus one control track. The positive film has identical perforations with the negative so that it can run on the same sprockets as the negative. The cameras are substantially as compact and only a few pounds heavier than conventional 35mm equipment. The regular cameras take 3 lenses: 37°, 48°, and 64° horizontal angle of coverage. The special "bugeye" 120° lens is permanently mounted on a separate camera. The special projectors are only slightly larger than conventional 35mm machines and can be installed in the ordinary booth. For the Todd-AO film they run at 30 frames/sec. The same projector will also handle 35mm film at 24 frames/sec with either optical or magnetic sound, to provide maximum flexibility for theater operation. A typical projection screen is 51-ft across by 25-ft in height with a curve 13-ft deep in the center. The actual screen length along the curve would be 65 ft.[6]

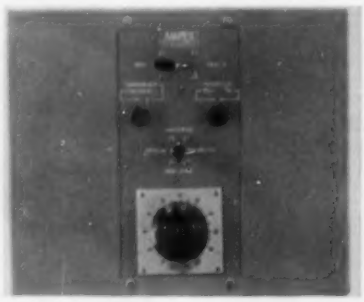

Fig. 8. Ampex theater switching panel.

Theater Sound Equipment

Many new types of theater sound equipment were introduced, including CinemaScope 4-track magnetic, single optical CinemaScope, single magnetic CinemaScope, optical Perspecta sound, etc. Westrex introduced a complete new line of theater sound reproducing equipment in June 1954. Their multichannel sound systems included an integrator for Perspecta sound. The R7 photographic sound reproducer uses a longer optical path and the Equilight Diffuser for improved reproduction of area or density prints. The Westrex multichannel amplifier equipment includes a T454 power amplifier with new circuits and especially wound coils. The 38-type cabinet is shown in Fig. 6. Emergency switching facilities are provided for use in the event of failure of one channel. A volume indicator is also provided to check proper balance between channels. The Westrex multichannel backstage equipment provides newly designed low- and high-frequency units and baffles. Their Type T502B loudspeaker assembly is shown in Fig. 7.

Ampex introduced a combined optical magnetic reproduction system capable of handling all types of soundtracks: single-track optical, single-track magnetic, stereomagnetic and Perspecta sound. The same power amplifiers are used for all types of sound. A single switching panel, Fig. 8, provides proper equalization for the various sound systems, for projection change-over, for emergency procedure and for volume control. The RCA Type MI-10939 CinemaScope 4-track magnetic cluster permits interchange without adjustment of any type. This eliminates installation adjustments for track position and azimuth.

The Magnasync PH-1435 Penthouse reproducer now uses formed steel-plate construction to provide additional scanning-cluster shielding. Low flutter is achieved with their Synkinetic filtering development. Their WC-435 and WC-1435 preamplification wall cabinets are used for multitrack sound reproduction, and their model MS-435 monitor and switching panel provides complete emergency switching for CinemaScope installations. The model LL-500 Magnaphonic scanning head is designed in a cylindrical configuration with center-hole mounting.

The Altec S-15 stereophonic amplifier system, Fig. 9, uses 4 separate 20-w amplifiers which can easily be serviced. All necessary controls and switching facilities are provided. Altec Lansing introduced two new loudspeaker systems for theaters seating up to 1200 people. A compact low-frequency horn and a cast sectoral high-frequency horn are used with increased frequency response for full utilization of the capabilities of magnetic sound.

Theaters — Foreign. Most German theaters have converted for multichannel and Perspecta sound reproduction. It is interesting to note that a group of German experts have submitted a proposition to the German Cinema-Photographers Society that only 2-channel magnetic recordings be released, using 1.6-mm magnetic tracks on the outside edges of 35mm film with a 1.27-mm width magnetic head. The single optical soundtrack would remain untouched.

Picture projection in France is being standardized at an aspect ratio at about 1.85 : 1, with anamorphic projection at aspect ratios at about 2 : 1.

Australian manufacture of Miracle Mirror Screens was undertaken, vertical seams being eliminated through the use of an electronic welder that welds the joints in the screen after sewing.

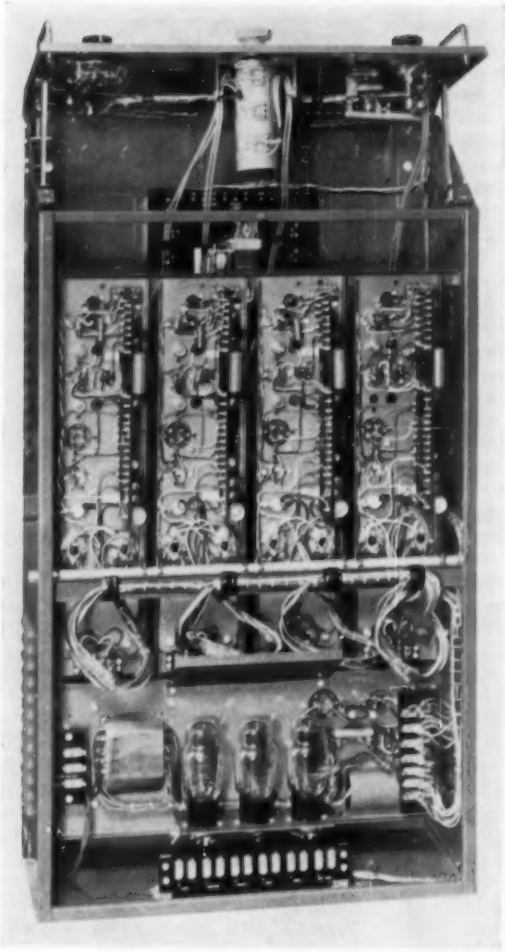

Fig. 9. Altec S-15 stereophonic amplifier system: case open.

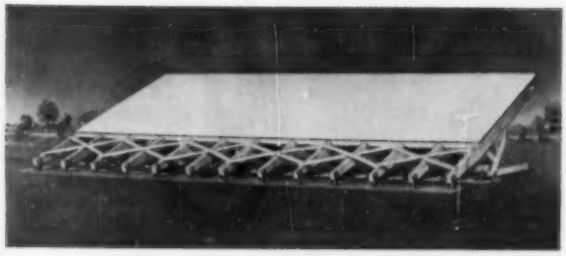

Fig. 10. Ballantyne screen tower: ready for erection.

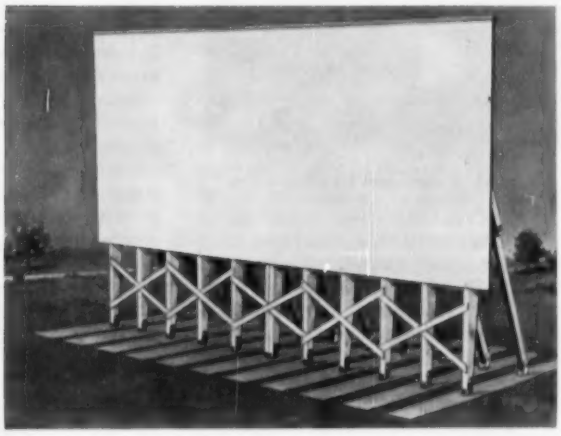

Fig. 11. Ballantyne screen tower: erected.

Drive-Ins

Over 4000 drive-in theaters were in service at the end of the year. Many have been installing much larger screens; one on Long Island is reported to be 60 × 120 ft. The Manco-Vision Screen, based on an earlier design by the Motion Picture Research Council, was introduced. It consists of extruded aluminum panels with proper curved flutes.

Ballantyne developed a new type of screen tower (Figs. 10 and 11), ranging from 56 to 64 ft in height, with unlimited width. Erection costs are a minimum since a tower is completely assembled on the ground. Heavy equipment is required only for the actual raising of the completed tower. Laminated trusses of high strength are employed. Ballantyne also made available stereophonic mixers that feature plug-in connections and compact construction, and a new self-sealing, self-aligning double-cone speaker unit (Fig. 12) which improves quality and eliminates removal of speakers from posts to facilitate repairs.

RCA introduced the PG-390 bridging and filter kit[7] used with two separate drive-in theater speakers located in each car. The left soundtrack is directed to the left speaker, the right soundtrack to the right speaker, and the center speaker track and the sound-effects track are divided equally between the right and left speakers. The PG-391A system parallels 4 magnetic tracks or may be used for the reproduction of a single magnetic track. The MI-9329A power amplifier is Class AB1, fixed bias 3-stage resistance-capacity coupled, 62-db gain, with an output of 150 w at less than 2% distortion from 40 to 62,000 cycles. This amplifier is a part of the PG-351 and 353 series drive-in theater sound systems, which feature a new dual volume control and an automatic phototube voltage regulator circuit. Power can be increased to 600 audio watts and up to 2400 car capacity. Magnasync introduced the model B-4-X "blender" preamplifier to combine multiple magnetic soundtracks into a single speaker.

In Australia 6 drive-in theaters have been built, with technical standards similar to those in America.

Projection

Air Cooling. In the projection of motion-picture film at high intensities for maximum screen illumination, it is sometimes desirable to cool the film and control its position with a blast of high-velocity air. A *Journal* paper[8] presents a method for

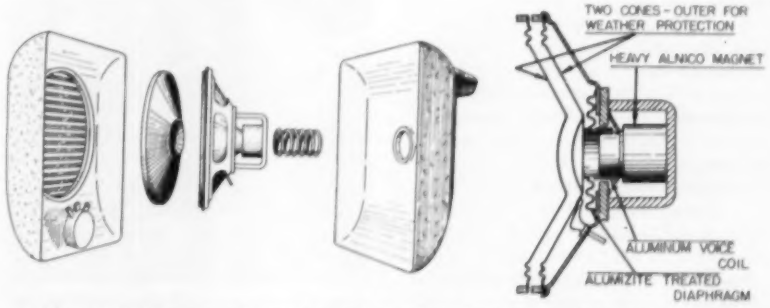

Fig. 12. Ballantyne self-sealing, self-aligning double-cone drive-in speaker.

Fig. 13. Paramount framing index.

evaluating the design, placement and operation of the jet that provides the cooling air. The heart of the method is the fact that the brightness of certain phosphors depends strongly on temperature. Such phosphors provide an immediate visual indication of the temperature distribution over the film face. Examples of several air-flow patterns revealed by the use of phosphors are discussed. Test results obtained by projection of film are compared with predictions.

Carbons. In addition to the 13.6mm high-intensity carbons for 125- to 160-amp operation and the 13.6mm Hitex Super carbon for 170 to 180 amp, National Carbon introduced the 11mm high-intensity carbon[9] for operation at 115 amp and a 10mm Hitex for 125 to 145 amp. These carbons have increased the screen illumination from 15,000 to 21,000 lm for the old style 10mm and for 13.6mm high-intensity carbons to 15,000 to 27,000 lumens. Many theaters during 1954 converted to the higher output carbons because of the adaptation of larger screens. It is expected that the Ultrex[10] carbons will be in commercial service during 1955.

National Carbon also introduced a new 8mm copper-coated Suprex carbon for nonrotating 60- to 70-amp operation. It produces 15% more light at the same burning rate and current.

Double-Frame VistaVision Projection. Counterparting the special cameras constructed for Paramount's VistaVision process was a VistaVision horizontal projector. This projector, manufactured by Century Projector Corp., is a horizontal 8-sprocket pulldown unit for the projection of the VistaVision aperture of 1.418 × 0.722 in.[11]

Projection Arcs. RCA introduced the Dyn-Arc, which features an 18-in. f/1.64 reflector. It uses 10mm and 11mm carbons and can take larger carbons at higher amperages when projectors and projection lenses are available to make this type of operation desirable for large indoor and drive-in theaters. A blower is provided for the heat-reflecting glass and exhaust. The positive carbon is water-cooled and sterling silver carbon guides are used. The increase in available light output requires proper design of the projector.

Projection Framing Index. To assist projectionists in the proper framing of wide-screen pictures, a new framing index was introduced by Paramount. An example of this framing index mark is shown on Fig. 13. This marker is properly located on the negative so that on the prints, when the upper horizontal line, extending to the *left*, is framed to the top of the theater screen masking, the picture will be correctly framed for screen aspect ratios between 1.66 : 1 and 1.85 : 1. When the lower horizontal line, extending to the *right*, is framed to the top of the screen, the picture will be properly framed for a 2 : 1 aspect ratio. This index is used at the start of "A" reels. As a further aid to the projectionist, several frames of the head leader of "A" reels will carry a black rectangle, Fig. 14, precisely placed to provide the proper head room for the projected image in aspect ratios of 1.66 : 1 up to 1.85 : 1. The frame control on the projector can be centered on this black rectangle in the aperture when threading up.

General. The Wollensak Cinema Vari-Focus projection lens, which was developed by P. C. Young at M-G-M, has been widely employed, a reported 6000 lenses now being in use. It consists of two chromatically corrected elements attached to the regular projection lenses. One of the elements is movable, enabling the focal length of the combination to be

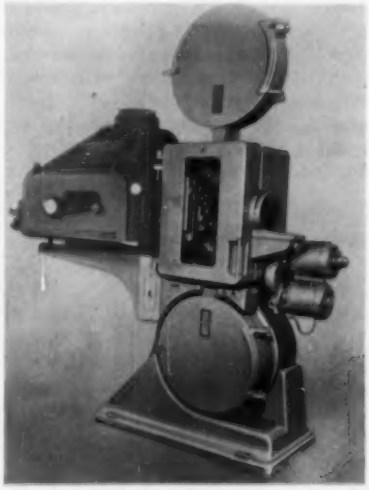

Fig. 15. Philips "All Purpose" Type EL-4000 projector.

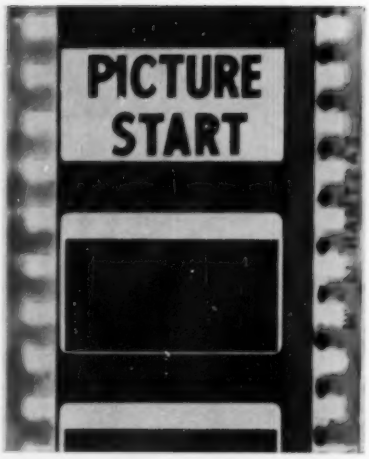

Fig. 14. Paramount framing leader.

changed so that various picture sizes can be presented in all nonanamorphic ratios.

The Strong Electric Company obtained a license under the Gretener patents to produce the Ventarc air-blown type of arc in the United States. Further improvements are being actively developed.

Hartner introduced their HT-135/270 TransVerteR motor generator for 135-amp operation at 90 v with a 270-amp change-over rating. A 30-hp motor is used. New types of ballast rheostats have been designed in which a pair of ballasts is incorporated in a single frame.

Foreign. The Philips "All Purpose" Type EL 4000 projector (Fig. 15) was completed; it will run 70mm film with any number of magnetic soundtracks, CinemaScope film with 4 magnetic soundtracks, CinemaScope film with optical soundtracks, or Perspecta sound, wide-screen films of any size, normal 35mm films, 3-D films made with a single-track system and 3-D films for use with twin film systems. Universal sprockets and rollers permit the use of 35mm and 70mm film from a curved and water-cooled film gate, single-bladed conical shutter, drive motors for 30 and 24 frames/sec, built-in optical soundhead and magnetic soundhead for CinemaScope 4-track films and Todd-AO 6-track films. Magazines are provided for 2000 ft of normal 35mm film or 3100 ft of 70mm film.

The German firm of Frieseke-Hoepfner introduced their Type FH 99 projector, which uses a 21.2-in. diameter mirror. Intended for drive-in use, it includes air and water cooling of the film and aperture mounting plate. It has two feed sprockets above and below the aperture and two intermittents to provide smooth film running by further filtering out any temporary bounces due to uneven winding or unwinding in the two film magazines.

Zeiss-Ikon have developed the Ikosol

II lamphouse using a Type XBO-1001 xenon bulb[12] which operates at 20 to 45 amp. This bulb operates at 5500 K with an output of 32,000 lm and an intensity of 40,000 stilb. The electrodes are vertical and the brightness portion of the gas ball, directly above the cathode is approximately 0.7 mm in diameter. The gas ball is bell-shaped and has approximately one-tenth the intensity of the center. The average width of the arc is about 1.7 mm and its length about 3.4 mm.

Background Projection

To improve the speed of operation and line-up of triple-head background projectors, Universal-International Pictures perfected a remote-control console that permits rapid focusing of three projector units and the proper adjustment of pan and tilt of the mirrors on the two side projectors.

Cameras

Many of the camera improvements made during 1954 have been reported.[13]

Underwater Photography. For underwater photography, M-G-M built two types of camera blimps, one for CinemaScope and the other for shooting wide-screen.[14] Buoyancy of the blimps is adjusted to neutralize the blimp weight when submerged. Remote controls for all camera adjustments are located on the outside of the blimp. The blimp is equipped with an Aqualung unit to provide buoyancy and protection against external water pressure.

The Disney Studios also designed a new type of pressurized watertight blimp to house a CinemaScope camera to film underwater scenes for *Twenty Thousand Leagues Under the Sea.*[15]

VistaVision. For both regular stage shooting and location photography all production at Paramount is now made with the newly designed double-frame, horizontal movement VistaVision camera built by Mitchell Camera Corp. (See report on VistaVision above.)

General. Bell & Howell introduced the Sports finder and also the Spider turret for the 70 DL camera. This turret takes any three lenses from 0.7 in. to 6 in. in focal length. The military-type Cunningham 35mm hand-held motion-picture cameras became available. These cameras are governor controlled for operation at 16, 24 or 32 frames/sec. The shutter is a 170° rotary type. The magazine is of the displacement type to reduce size and weight. It holds 200 ft of film and contains the complete film-movement mechanism with the dual-pilot pin-registration unit of the Mitchell type. A follow-focus attachment for Mitchell 35mm NC Standard and Professional 16mm camera was made available. This facility is already an integral part of the Mitchell BNC studio camera.[16]

The Arriflex camera was redesigned so that the pulldown claws are 100% at rest while touching the film at the beginning of the pulldown as well as throughout the entire pulldown cycle. The reflex shutter has been changed to 180° and a sound-proofing blimp has been especially designed for the Arriflex 35.

A new press sequence camera (Model No. 102-Press) has been developed by the Hulcher Co. using their typical beater type of movement (Fig. 16). This camera, while using 70mm film, is capable of operating at rates from 5 to 20 frames/sec, each picture being $2\frac{1}{4}$-in. high and $2\frac{1}{2}$-in. long. The exposure range is from 1/25 sec at the 5-frame rate to 1/2880 sec at the 20-frame rate. Daylight-loading 100-ft film spools are used. The total weight of the camera is $12\frac{1}{2}$ lb.

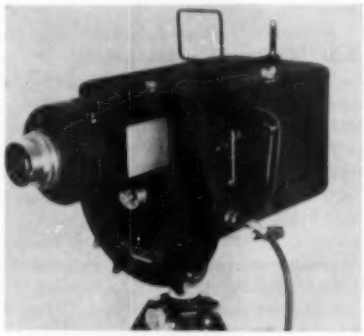

Fig. 16. Hulcher Model 102-Press sequence camera.

To satisfy the ever-increasing demands, particularly by the Military, for higher speeds, the Mitchell Co. has developed and can now supply a camera equipped with an intermittent and registration-pin mechanism capable of photographing up to 225 frames/sec. The general exterior of the camera is the same as that of the present high-speed camera, only the intermittent being changed.

In order to gain a larger picture area, Photo Sonics, Inc., has brought out a 60-frame/sec, 70mm film camera (70mm 5A recording camera) which produces a 1.156 × 2.25-in. picture. The camera was developed primarily for aircraft use and therefore the exterior design is patterned to allow easy mounting in aircraft. It has a film capacity of 400 ft and uses an intermittent mechanism fitted with registration pins. The shutter is of the disk type and allows exposure apertures up to 120°. Using the same type of intermittent with registration pins, another camera (70mm 5B recording camera), intended for more general use, is available from the company. This camera is designed to provide three speeds (20, 40 or 50 frames) and uses either 400 or 1000-ft Mitchell magazines. A buckle switch and resettable footage counter are built-in features.

Another high-speed camera using an intermittent with registration pins is commercially available from the W. Vinten Co. of London, England. According to their catalog their HS-300 high-speed camera is capable of operating at a rate of 40 to 300 frames/sec, the picture area being 1 × $\frac{3}{4}$ in. The shutter (2-bladed) is adjustable to provide exposure angles from 10 to 170°. Provision is made for recording a 50-cycle/sec time base line.

Camera Exposure. A psychophysical study has been made of the relationship between the tone-reproduction quality of a positive motion-picture screen image and the camera exposure[17] for the corresponding negative throughout a series of negative exposures for each of 16 outdoor scenes and 8 indoor scenes. A description is given of the method used for obtaining psychometric data, and curves are presented showing the relationship between screen-image quality and the logarithm of the camera exposure. The use of these curves in determining exposure latitude, speed and exposure index is discussed.

Optical Equipment

Many developments were made in optical equipment during 1954 for TV and motion-picture use.

Anamorphic 35mm Camera Lenses. Bausch & Lomb announced a series of one-piece CinemaScope camera taking lenses designed to fill the need for a variety of focal lengths. This series of lenses, consisting of focal lengths of 35, 40, 50, 75, 100 and 152 mm, is said to offer high-resolution and low-distortion characteristics.[18]

Anamorphic Optical Printing Lenses. Panavision Inc. introduced the Micro-Panatar optical unit for conversion printing from CinemaScope to uncompressed standard prints and from standard photography to CinemaScope compressed prints. Various special models are available for a combination anamorphosis and reduction.

The Superscope anamorphic process starts with normally photographed negative 0.650 × 0.980 in. with essential action composed in 0.480 × 0.960 in. Anamorphic release prints made in the laboratory in a compression ratio of 2 : 1 can be projected by standard theater-type anamorphic projection systems.[19] The Superscope printing lens has a resolving power between 70 and 75 lens/mm and can be used to any degree of anamorphosis from 1.1 : 1 to 2 : 1, either compressing or decompressing the image.

Double-Frame Camera Lenses. The Zeiss Biogon, 21mm $f/4.5$ was introduced for VistaVision and other wide-film uses. The Zunow 50mm $f/1.1$ was announced, and the Leitz Summicron 50mm $f/2$ found wide use. The Cooke Double-Speed Pancro 40mm $f/2$ was also made available.

Todd-AO Lenses. Special camera lenses were developed, covering horizontal angles of 37°, 48°, 64° and the new "bugeye" 120° model.

Projection Lenses. Kollmorgen introduced the $f/1.7$ and $f/1.7$X Super Snaplite projection lenses. The latter lens consists of an "extended" optical system that "pipes" the projected beam through the projector mounting mechanism, thereby reducing the mechanical vignetting present with many short-focal-length projection lens installations. The $f/1.7$X is available in a focal-length range of 2 to 4 in. in $\frac{1}{4}$-in. steps.[20] Projection Optics Co. announced the Hilux $f/1.8$ projection lens, said to be designed especially for maximum edge-to-edge definition for wide-screen applications. These lenses are mounted in hermetically sealed one-piece mounts.[21]

Wollensak and Pacific Optical both introduced varifocus projection lens attachments to provide a variety of wide-screen aspect ratios (nonanamorphic) when used in conjunction with the basic projection lens. The Wollensak unit is named the Cinema Vari-Focus Projection Lens and the Pacific unit the Xpansa.[22,23]

Prismatic Anamorphic Projection Attachments. Panavision Inc. introduced the Super Panatar Model 100 variable anamorphic attachment, which provides one-knob control for horizontal magnification changes from zero to two. Their Super Panatar Model 400 is similar in design but is adapted for 4-in. diameter prime lenses. Corrector lenses for any projection throw are variable.

Superscope Inc. introduced a variable prismatic projection attachment, variable from 1.33 : 1 to 3 : 1. One knob controls the variable horizontal magnification, while a vernier control knob centers the projected area on the screen. The prisms are achromatic doublets, with each element ground from an apex of 0.62 to a base of 0.500 to 0.700. The surfaces are flat to $\frac{1}{4}$ wave and are anti-reflection coated. Twenty-five hundred Superscope installations are reported. A Superscope definition-intensifier may be added to the front of the projection lenses to collimate the light rays and reduce the astigmatic condition, which may be aggravated by short-throw projection.

Projection Optics introduced the Hi-Lux Val variable anamorphic attachment,[24] which has two-knob control for changing the anamorphic horizontal magnification from zero to two. Corrector lenses are available for any projection throw. The attachment is designed to fit a 4-in. diameter projection objective lens in addition to the smaller size.

In Germany anamorphic projection lens attachments are being marketed by Carl Zeiss-Werk in Oberkochen in addition to the Cyligon, Isco, Anamorphic Kiptar, etc.

16mm Camera Lenses. Bell & Howell announced a new 1-in. $f/1.9$ lens manufactured by Taylor, Taylor & Hobson of England as standard equipment on all Bell & Howell 16mm cameras ordered with an $f/1.9$ lens. This new lens is said to offer better correction of aberrations and higher resolution than previous $f/1.9$ lenses.[25] Also announced by Bell & Howell was a 3-in. $f/2.5$ telephoto lens made by Angenieux of France for use on 16mm "C" mount cameras. This lens, which is of a 5-element design, measures only 2.4 in. from the front lens vertex to the film plane.[26]

J. L. Calef introduced the Oude Delft Vistascope lenses for 8mm and 16mm motion-picture presentation. These are supplementary lens prism systems to be used in conjunction with the regularly supplied camera and projector lenses producing an aspect ratio of the projected image of 2 : 1. The anamorphic ratio of these units is 1.5 : 1.[27]

A 230mm (9-in.) $f/3.8$ Tele-Athenar lens became available for 16mm cameras It may be focused as close as 15-ft and stops down to $f/22$. The fast $f/0.95$ Nominar 1-in. lens was also introduced.

Television Camera Lenses. For television pick-up cameras a 35mm $f/2.5$ Angenieux lens covering a total field of 64° was introduced, filling the need for a high-resolution, quality lens, of short focal length.[28] Camera Mart Inc. offered a rotating lens adaptable to 16mm and 35mm motion-picture and television cameras for the purpose of reproducing images at any angle.[29]

A camera focus autocollimator was announced by Taylor, Taylor & Hobson of England for visually checking the accuracy of the focus adjustment of camera lenses without the necessity of resorting to test strips. This autocollimating unit utilizes reflections from the emulsion of the film to verify the lens adjustment.[30]

Zoom Camera Lenses. Zoomar Inc. introduced the TV Studio Zoomar (Fig. 17), which has a speed of $f/2.8$ and a focal range from $2\frac{1}{2}$ to $7\frac{1}{2}$ in. One hand control provides zoom operation by pushing or pulling the zoom rod while close-up focusing is done by turning the zoom rod. This lens can be used on both color and black-and-white television cameras, together with lenses on the same turret.

The Zoomar 35 for motion-picture studio work, Fig. 18, has a maximum speed of $f/2.8$ and a zoom range from 40 mm to 120 mm. It is lever-operated and has a coupled, free-vision viewfinder. The Zoomar 35 is available on a rental basis only.

The Zoomar 16-S is a new lens with a speed of $f/2.8$ and a zoom range of 1 to 3 in. (Fig. 19). It does not have a coupled viewfinder. Instead, a space mount is provided for its use on an Arriflex camera; it is also used with industrial television vidicon cameras. The zoom

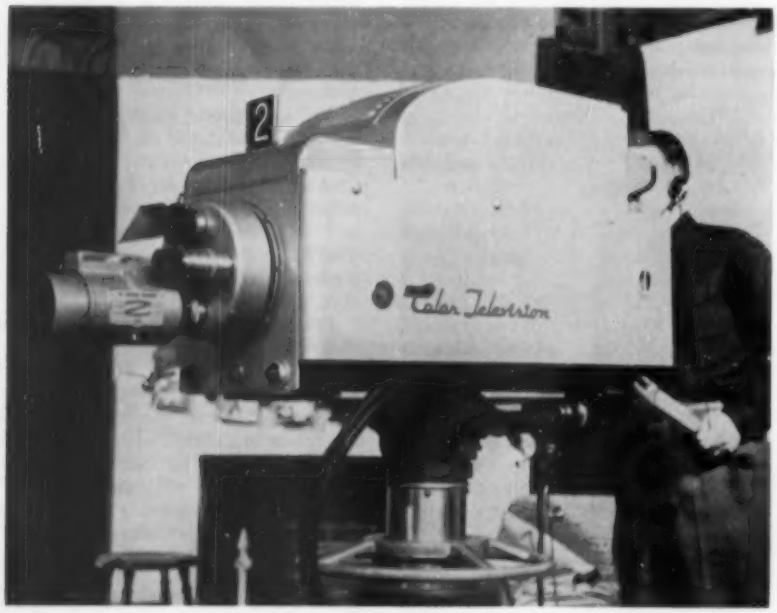

Fig. 17. TV Studio Zoomar lens.

Fig. 18. Zoomar 35 lens, designed for motion-picture studio work.

Fig. 19. Zoomar 16-S, a special version of the 16mm Zoomar lens.

control is by hand, but it can also be made remote. The Zoomar 16mm lens was adapted for use on the Auricon-Pro 16mm single-system camera.[31]

The new GPL-Watson zoom lens is now widely used in TV cameras. It is an improved optical facility for remote special-event pickups, and has focal ranges from 3 to 15 in. and 6 to 30 in. which can be used interchangeably. This lens has reduced the stringent lighting requirements necessary with many other long-focal-length zoom lenses.

Optical Printing

The importance of optical printing to the industry has grown considerably during 1954 because of the many new aperture sizes and photographic methods in use, together with the varied requirements for general theater release of pictures using the new systems.

CinemaScope is being unsqueezed and reframed to normal academy aperture for the general release of pictures and trailers to the many theaters with the 3 × 4 screens. Stock material is being squeezed or unsqueezed to fit the standard required. Anamorphic printer lenses used for this work are the Tushinsky and Panavision. The Tushinsky Superscope system has made its bow, anamorphically converting full-aperture flat negatives to a 0.715 × 0.715 aperture for projection through CinemaScope lenses. This makes it possible for the producer to shoot his picture with standard full-aperture equipment and, by means of a Technicolor squeezed matrix or dupe negative, to project a wide-screen picture in any desired ratio.

The VistaVision process has brought about the development of new optical printing equipment to produce normal-frame dailies, master prints or dupe negatives. This equipment consists of an optical printer with its projector head mounted at a 90° angle and fitted with a movement for an 8-sprocket hole pull-down. A similar setup is required to make a normal frame Technicolor matrix.

The field of 16mm blowup for 35mm theater release has progressed firmly, even though the screen has been enlarged. New developments with the Eastman Color 35mm blowup negative are now making it economically possible for the producer to obtain a limited number of release prints with excellent quality. In Hollywood extensive work in this field is being done by FilmEffects and Cinema Research Laboratories.

With the advent of 16mm Eastman Color positive raw stock, Pathé in New York and Consolidated in Hollywood were among the first to set up reduction release printers for its use. Prints from either original or duplicate color negatives have shown outstanding results in color quality and definition. Producers who are interested only in a 16mm release are now finding it very worth while to photograph on 35mm color negative; and even though intended for black-and-white use at present, many of the television shows are being made in this manner, with an eye toward future use for color TV.

Sound

Stereophonic — CinemaScope. Twentieth Century-Fox records all original dialogue and sound effects, wherever possible, with a 3-microphone stereo pickup. All music, including vocals, is recorded with 3-channel stereo. Release is stereo, the No. 4 track to the surround theater speakers being used wherever appropriate.

M-G-M, Columbia, Universal and Warner Bros. record all original dialogue and sound effects with a single-microphone pickup. All music, excluding vocals, is recorded with 3-channel stereo. Vocals are for the most part recorded with a single-microphone pickup. Release is stereo music and single-track dialogue, which is usually pan-potted or distributed between the three stage speakers according to the picture action. The No. 4 track to the surround theater speakers is used where appropriate except in the case of Columbia, who have not used it thus far.

Warner Bros, and some other studios make a special effort to record significant sound effects on 3-channel stereo. This is done particularly on those effects which are important to the story. For example, aircraft sound effects were recorded stereo for *The McConnell Story*, dealing with the life of an aircraft pilot, which includes many flying sequences in a great variety of aircraft.

Stereophonic — Todd-AO. Sound recording on *Oklahoma* for Todd-AO was made on special Westrex recorders, laying down six 100-mil tracks on 35mm film. The signals were fed from two 4-channel mixers, the fourth channel in each case carrying a roving mike that may be used with any of the other three channels. A useful frequency range of 40 to 12,000 cycles was obtained. Five channels supplied speakers behind the screen, and a sixth channel was used for surround effects. Elaborate new dubbing equipment is under construction.

Magnetic Transfer. Columbia Pictures developed an improved magnetic transfer machine that is capable of high-speed operation, automatic edge numbering during the transfer operation, reduction

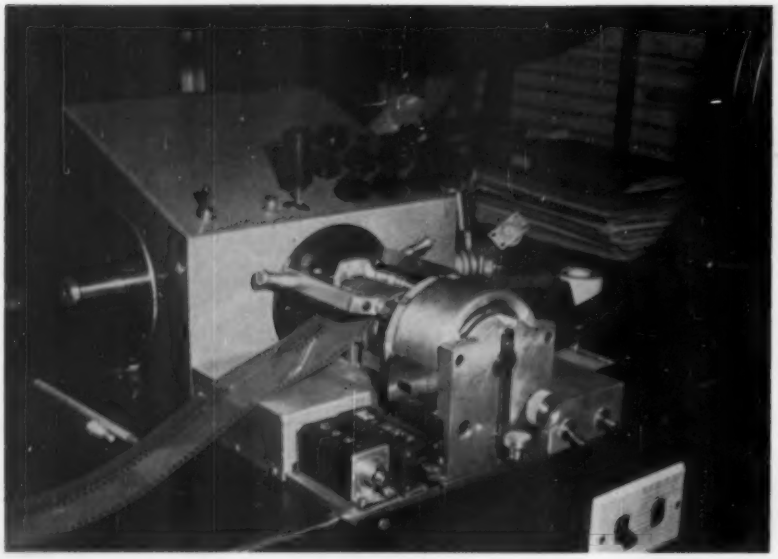

Fig. 20. M-G-M magnetic-film editing machine.

of wear on the magnetic heads and "running interlock" or "standard interlock" operation. They have also developed a Multiplex Electronic Monitor to sample the recording of magnetic prints.

Electronic Printer Comparators. Electronic comparators were developed by M-G-M and Columbia to sample the signal amplitudes of the prints of the 4 magnetic CinemaScope soundtracks by comparison to the 4 master magnetic tracks. In the M-G-M Comparator[33] voltage amplitudes are integrated over approximately 40 msec, the algebraic difference of integrated voltages being fed to a differential amplifier with a zero-center voltmeter in the output. The meter shows the amount and sense of the error voltage. A relay is provided to operate a warning light and audible alarm when the integrated discrepancy exceeds ±1 or 2 db. Over 21 million feet of release print were inspected without a single field complaint of printing failure.

Editing Equipment. The editing of single and multitrack magnetic film is simplified in a compact machine developed by M-G-M (Fig. 20). The device includes 6 reproducers and will accommodate split or wide film, or picture and track. A selected frame interval in any value from 5 to 32 frames is reciprocated continuously over the stationary reproducing heads. A clutch permits instantaneous start, giving true pitch for music. Automatic sound muting or film reversals prevents garbled sound annoyance. Turning a differential control while reciprocation continues allows displacement of the selected frame interval to the left or right of the pickup heads, thus locating the beginning or end of the desired signal.

M-G-M has also developed a very compact magnetic film cutter and butt splicer which is small, is easily operated and can be kept on the cutter's table. It will make angle or straight butt splices on 35 or 17½mm film.

Magnescope Corp. introduced their cathode scanner, which displays directly on a cathode-ray tube a static graph of the waveform of any type of magnetic tape. No pole pieces or switching circuits are involved. For synchronization work the tape is moved over the face of a window until the desired sound is heard and the modulation can then be seen on the tube.

Microphones. The Altec M-20 microphone system incorporates the latest improvements in the Altec 21 type of condenser microphone for broadcasting, recording and public-address use. Its small size and extended frequency response make it ideal for use in stereophonic magnetic recording systems.

Miscellaneous. Samuel Goldwyn Productions Inc. have extended the use of their "graphic equalizer," and it has been generally adopted throughout the industry by re-recording mixer personnel. The 6 sliding equalizer control knobs are vertically arranged to indicate visually the amount of equalization in each of the 6 bands. The Flexipan was developed by M-G-M to simplify the re-recording of stereophonic sound.

Ferrite-core magnetic heads[33] were introduced as an addition to the usual laminated heads. Final evaluation of the merit of this development is still under way.

Foreign. Klangfilm in Germany has developed a sound recording truck for magnetic recording only.[34] They have also developed a special magnetic sound recording camera used with the Auricon Super 1200 camera.[35] It is also reported that they now license all users of professional sound equipment in Germany.

New German mixing consoles[36] have been developed, including one with 14 single-channel inputs and 4 triple-channel inputs for stereophonic recording.

Perspecta Sound

Perspecta sound production recording and Perspecta and sound integrator units for theaters were introduced. Picture releases with this system included the CinemaScope production, *Knights of the Round Table* (M-G-M), *White Christmas* in VistaVision by Paramount, and *The High and the Mighty* in CinemaScope by Warner Bros. Nine service studios have been authorized to record Perspecta sound and eleven other producers have been licensed in Hollywood, England, Italy, Switzerland and Austria. Approximately 70 new feature productions, 10 re-issued features and several short subjects are in circulation using Perspecta stereophonic optical soundtracks.

Sound integrators are being made by Fairchild Recording Equipment Co., Stelma Inc., and several other companies in the United States, and 18 foreign manufacturers have been licensed.

Perspecta recordings control the level of the left, center and right speaker by means of 30-, 35- and 40-cycle control signals superimposed on the single photographic soundtrack. In preparation for final release, a separate control-track film is made from word cues on the original material by means of panpots. The combination of these three control signals for final release is at least 23 db below full modulation. They are timed 12 to 14 frames ahead of action. For center action the left and right horns are normally held 8 to 10 db below the center horn but either may be increased about 14 db by the control signal to simulate a stereophonic effect. Perspecta soundtracks also play their single-sound theater system without modification of the theater equipment.

Magnetic Recording and Striping

The quality of full-coated 35mm magnetic film for recording purposes has been steadily improved to the point where it may soon be possible to use it without inspection.

Magnetic Striping. The editorial use of magnetic stripe film steadily increased in comparison with editing on optical sound film. Reeves Soundcraft Magna-Stripe and Ryder Sound Services RyderStripe provide striped editorial film, while Minnesota Mining & Mfg. Co. is supplying their Scotch Brand stripe film as a

laminated structure, using the new high-output type of oxide.

Minnesota Mining introduced their Scotch Brand Magnetic Laminate or Scotch Track. Their magnetic laminator applies magnetic oxide soundtrack material in strips to 16mm film. A small wick moistened with cleaning solution cleans a narrow path on the film where the magnetic track is to be applied. A slitter cuts the laminate tape to the desired track width. Micrometer controls adjust width selection and track placement. An electric heater activates the adhesive, and the laminate tape is then rolled under pressure into a firm and permanent bond with the film. The temporary plastic backing is then stripped from the tape.[37]

Magnetic Striping — Foreign. In Europe the use of magnetic striped materials has increased, particularly in 16mm among television users. The European Broadcasting Union is proposing to standardize 16mm prints with negative striped track as an alternative to the photographic track. The German Broadcasting authorities have been using such prints for several months. The British Broadcasting Corp. has been experimenting with 16mm magnetic striped raw stock on black-and-white films and will later extend it to color.

Anorgana, a German firm, is marketing magnetic paste for striping 16mm film. Inventors in Munich have perfected a process of milling a groove into the film emulsion for insertion and gluing of a very thin "mass" tape. The magnetic particles are distributed throughout the thickness of the tape material. Film striped in this manner winds evenly without increase in diameter on the magnetic stripe side.

Black-and-White Film

Tri-X film was introduced by Eastman Kodak as a new, very fast black-and-white negative. With an ASA rating of 200/250, it has found extensive use on the production *Black Tuesday*, and for newsreel, TV and commercial production, both here, in Canada and abroad.

Perutz in Munich markets a new type of 16mm reversal film with a speed of 21/10° DIN. They describe their new 16mm reversal process which eliminates the "exposure equalization" step.[38]

The new Gevaert Type 562 black-and-white fine-grain release positive film shows a colder image color than current fine-grain release positive materials without a noticeable change in graininess. Gamma remains essentially unchanged over a wide range of development times around the working gamma value of 2.50.

Examination of developed silver halide grains with the electron microscope showed the grain within a combined envelope that is a relatively inert and insoluble skin. This envelope may consist of a gelatin complex with silver lens in the grain complex.[39]

Color Film

Foreign Use and Facilities. In Europe there has been a steady expansion in the use of integral-tripack color films during 1954. Eastman color-film processing facilities were extended in England, France, Denmark, Germany and Sweden. The manufacture of Eastman color print film commenced at Kodak Ltd. in London and Kodak-Pathé S.A. in Paris.

Technicolor Motion Picture Corp. is reported to have completed arrangements for installing a complete color-film processing laboratory in Joinville, near Paris, to be called Société Technicolor.

Nearly all European processing plants have been converted to handle Agfa, Eastman, Ferrania and Gevaert color films.

Agfa introduced color negative materials in two contrasts. Matching color release positives in two contrasts are also available.

A new Gevacolor negative, Type 652, was introduced having an ASA 40 rating and balanced for 3200 K. It has the same order layer and dyes as the earlier Type 651. The new Gevacolor positive, Type 952, which was also introduced, has the same order of dye layers as Eastman color print film and similar color contrast characteristics. The new positive permits adoption of soundtrack redevelopment since the yellow silver filter layer is no longer employed.

The Canadian developing facilities for Eastman 35mm color stocks have been provided by Associated Screen News in Montreal and Audio Pictures Ltd., Toronto.

In France 25 color motion pictures were made in 1954. Eastman color negative, Gevacolor, Ferraniacolor and Agfacolor were used, with most of the printing on French-manufactured Eastman color positive. Most French laboratories are equipped to process multilayer negative and to print on multilayer positive. Debrie D.U.C. and other color processing equipment is used with printing on the Debrie color printing machine. Intensive work has improved the quality of duplication color negatives. The Debrie D.U.C. Type F2 developing machine is shown in Fig. 21, and details of the plug-in electric turbulation motors are shown in Fig. 22. The Matipo color contact printer is shown in Fig. 23.

In India the only color film now used is Gevacolor; 600 ft of negative and 4000 ft of color positive can be handled per hour. The printers are the Debrie Matipos, including the latest additive type. Construction of another laboratory to handle Eastman color is under way in Bombay and other laboratories are planned for Madras and Calcutta. Arrangements have been made to manufacture Debrie cameras and printers in India.

Latensification of Color Film. The latensification of multilayer color film was reported[40,41] by the National Film Board of Canada and demonstrated at the May 1954 SMPTE Convention. The post-exposure method for raising the speed of Eastman Color Negative 5248 from ASA-24 to ASA-80 is described. This is an extension of the latensification work at Paramount Pictures on both black-and-white and color films in 1946–1947.

Ansco. The color reproduction of Ansco Type 238 color, 16mm, and Type 538, 35mm, color reversal duplicating films were improved by a change of the magenta dye coupler in the film, producing better hue and saturation in the red and magenta colors.

Ansco Type 844 color negative camera film was satisfactorily used on closed-system tests as a color kinescope recording negative, with prints on Type 848 color positive.

Masking. Color photographic masks[42] can be applied to minimize color-reproduction errors. Overlapping absorptions of the dyes probably cause the most serious errors and therefore receive the most attention. It is shown, however, that the lack of negative portions in the required sensitivity distributions contributes appreciably to the reproduction errors and can, at least partially, be corrected for by masking. One set of masking equations is derived to correct only for the overlapping absorptions of the dyes. A second set is derived to correct for the lack of negative portions in the sensitivity distributions. It is shown that the set of equations obtained by combining these two sets of equations is essentially the same as that derived directly to correct for these two sources of reproduction errors considered simultaneously.

Tone and Color Reproduction. The problems involved in obtaining optimum tone and color reproduction in 35mm motion-picture color prints are discussed.[43] A color negative material is used for exposure in the camera and three separation positives are printed from it; then a duplicate color negative is made on an internegative material from the separation positives. The influence of the sensitometric characteristics of the individual films of this system requires the careful use of sensitometric analyses at each stage to determine the optimum printing and processing conditions. A procedure is described which has been found helpful in determining these conditions.

Sound on Color Film. Silver deposits provide the simplest means of obtaining satisfactory sound reproduction from

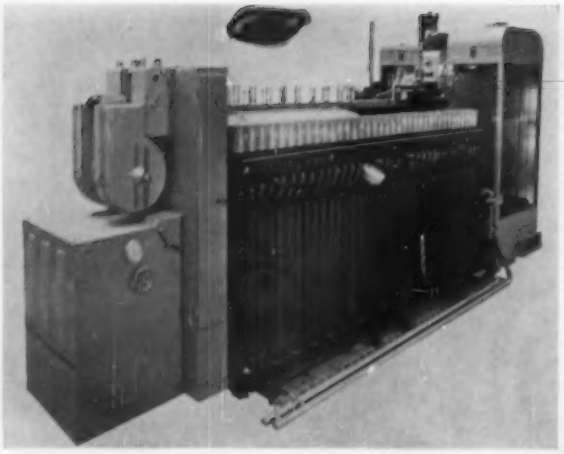

Fig. 21. Debrie D.U.C. Type F2 developing machine.

Fig. 22. Debrie D.U.C. Type F2 developing machine: plug-in turbulation motors.

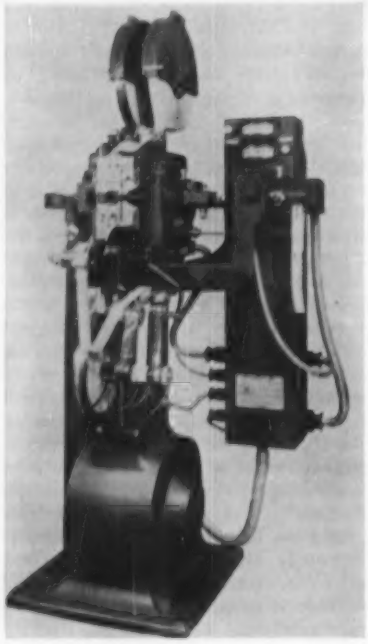

Fig. 23. Matipo color contact printer.

color films[44] when the phototube has the standard S-1 response. Some factors are discussed affecting the dimensional characteristics of redevelopers applied by roller or extrusion methods. The formula of a new soundtrack developer for the Eastman color print films is given. The method of selecting coating side may be useful for dimensional stability of applied solutions.

A soundtrack developer applicator of the roller type is described.[45] It gives soundtracks of high quality and operates from the lowest practical processing-machine film speeds to over 340 ft/min. Design features are discussed. Important to the success of the applicator is a highly efficient squeegee which is described in detail.

Color Filters. Color filters used in sensitometry have usually been made of gelatin and glass combinations. During the past few years interference filters[46] have become available which provide greatly improved densitometry because of their inherently greater stability and narrower passbands. Tricolor and soundtrack densitometry can at present be very well accomplished, employing the Fabry-Perot type of filters. Multilayer Fabry-Perot filters may prove to be even superior. Fabry-Perot filters can also be used in a color densitometer to convert it to an abridged spectrophotometer. Excellent near-infrared elimination in color densitometers can be accomplished by means of dichroic filters.

Film Processing and Printing

Densitometry. Much progress was made during 1954 in the field of color densitometry. Most of the new color densitometers that have appeared on the market are capable of being used as black-and-white machines simply by proper filter selection.

Westrex introduced the RA-1100E and RA-1100F densitometers for use in color film processing control.[47] The RA-1100E evaluates negative and positive color films by means of sets of tricolor filters specified by the film manufacturers. It will also handle negative and positive black-and-white control strips. The RA-1100F has been specially developed to evaluate dye-with-sulfide and dye-with-silver soundtracks by means of a monochromatic beam of infrared light. The instrument also handles conventional tracks and negative and positive black-and-white control strips.

The Dual Head Spectra Color Densitometer is manufactured by the Photo Research Corp. (Fig. 24). Soundtrack densities are measured on the right side of the instrument as shown in the photograph. An infrared phototube and appropriate filters are used to match the projection phototube system. The left head, with its separate light source, chopper, optical system and phototube, contains the narrow band filters for measuring the three color densities as well as filters for measuring print and visual black-and-white densities.

Ansco described[48] an automatic recording color densitometer that automatically plots red, green and blue densities, and black-and-white densities as well. It is in use at the Ansco plant in Binghamton for routine quality control measurements.

A series of papers pertinent to color densitometry have appeared in the Journal of the Optical Society. They carry the general title "An Objective Method for Determination of Equivalent Neutral Densities of Color Film Images." The first[49a] defines and gives the basic concepts; the second[49b] describes the determination of equivalent neutral

densities; and the third[49e] describes densitometer calibrations.

A simple microdensitometer was also described.[50] It is a scanning unit which may be used in conjunction with a normal microscope. An enlarged real image of a film sample is moved across a stationary slit. The image motion is provided by a rotating block of glass. An electrical signal (from a phototube behind the slit) is converted to a density signal and is presented on a cathode-ray oscilloscope. Some uses of the microdensitometric traces are suggested.

The National Film Board in Canada started use of the Eastman Model 31A electronic color densitometer.

Three papers[51,52,53] on color sensitivity and densitometry were presented by Eastman Kodak at the October 1954 SMPTE convention.

Printers. For color printing, Consolidated Film Industries has perfected a printing machine that has a triple light source and performs continuous contact printing of multilayer color motion picture positive from a single color negative. The three light sources converge evenly on the printing aperture, and each beam is modulated by a conventional traveling matte.

The Bell & Howell Design 5205 film printer provides a tenfold increase in light output for making 16mm and 35mm prints. The 300-w lamp increases the light from 20.2 to 21 ft-c. An air-duct frame holds filters in slots surrounded by air streams. An increase in uniformity of illumination across the aperture is obtained. The new light source may be fitted to existing Bell & Howell printers.[54]

Because of the increased need for the control of motion-picture printers used for printing color films, a simple barrier-cell type of light meter[55] was designed for use on release printers. The meter has very good stability and linearity of response. Its sensitivity is very adequate for the intensity levels encountered in release printers. The probe unit contains a filter magazine that permits rapid reading through red, green and blue filters. It was designed to give a photocell response that closely approximates the responses of the three sensitive layers of Eastman Color Print Film, Type 5382.

The Union Tonfilm Maschinenbau in Germany has completed the new Selecta continuous color-film printer with a fully automatic color correction system by means of mixed filters. The same firm also completed, under the name Multisonor, a magnetic sound printer for 35- and 16mm film. Detailed information may be obtained from a branch of this firm which has been established in this country under the name United Movie Technicians, at Hackensack, N. J.

Control of the Kodachrome color processing was described by A. M. Koerner[56] in these operations: (1) establishment and specification of the desired levels, (2) continuous evaluation to determine whether specifications are being met, (3) diagnosis when they are not met and (4) taking corrective action.

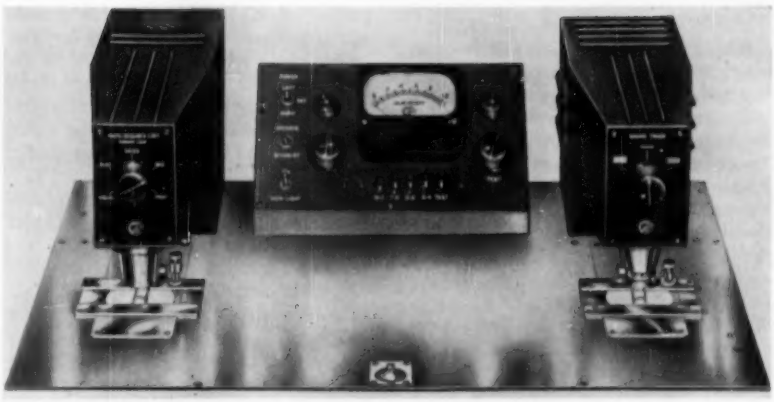

Fig. 24. Photo Research dual-head spectra color densitometer.

Soundtrack applications to color film and the control of redeveloping solutions applied to the soundtrack areas of color print films are described.[57]

Film Splicing. A new splicing machine[58] for the du Pont Cronar film was demonstrated. Du Pont also introduced a new splicing technique of using thin, perforated, transparent adhesive tape made from Mylar polyester film. The two films that are to be held together are joined with the tape, eliminating the need for clipping and cementing.[59]

A Pfaff "zig-zag" type of sewing machine has been used in the development of an automatic stitch splicer[60] for splicing 35mm film before processing. The complete splicing operation can be done quickly and easily in the dark with a minimum of operator training. The splice, made with nylon thread, has several features not found in tape, staple and heat splices. Most important are strength with flexibility, no effect from solutions or softening of film and no damage to equipment used on the processing machine.

Miscellaneous. The National Film Board of Canada increased by 50% the output of its 16mm developing machines by raising developer and hypo temperatures from 68° to 72°. Silicone rubber squeegees, pressing against both base and emulsion side of the film, sufficiently reduced the carry-over of developer to the short stop hypo and wash.

An Ingman tower electrolytic recovery unit made by Artisan Metal Products, Boston, was installed by the National Film Board of Canada with excellent results.

Arnold & Richter in Germany have developed a synchronizing switch that gives impulses varying from 0 to 10 min to a replenishing unit that will automatically refill the developer tank with 500 cc of replenishing fluid.

The inorganic developer system of Roman, employing a divalent vanadium ion as the active developing agent, has been further investigated.[61] A solution prepared from vanadium pentoxide, sulfuric and hydrobromic acids and reduced by electrolysis was found to double the speed of motion-picture positive emulsions, giving development times of the order of 20 sec at 60 F. Other sensitometric properties can be controlled to match those produced by conventional processing. A motion-picture film processing machine employing the vanadium developer has been devised and tested and is described. Developer activity is maintained by continuous electrolytic regeneration of the solution, replenishment being made only to balance carry-over losses. Another paper by these authors[62] contains more experimental data, and data on hypo determination is covered in another article.[63]

Measuring Instruments

The Photo Research Corp. introduced a new model of their Spectra Brightness Spot Meter which measures color temperature in addition to direct readings of brightness. For brightness readings a $1\frac{1}{2}°$ angle view is used. A $\frac{1}{2}°$ angle pickup can also be obtained. The logarithmic microammeter scale is approximately uniform over the top nine-tenths of the scale. Supplementary lenses are available for measuring very small spot diameters at short distances. An exterior meter is used for direct readings of color temperature of the light source. A separate filter is built in to measure brightness with the color response of the TV image orthicon.

The Came-Radar is a device for measuring set lighting. It was developed in France and has been adapted to the Eclair Camerette. The sensitometric probe is 1 mm × 3 mm in size and is capable of measuring exactly the luminosity of any point in a scene to be photographed.[64]

Set Lighting

Higher levels of set lighting became more common with the wider use of color film and the change to the newer camera techniques. The use of the 10-kw incandescent lamp increased. A series of "noise-free" incandescent lamps for motion-picture set lighting was announced by the General Electric Lamp Division. More studio use was noted of the large reflector type of lighting units that provide overall fill light.

Matte Lighting. Warner Bros. have developed a ventilated light source that is particularly useful in illuminating matte shots, paintings for matte shots, miniatures, inserts and other types of special effects for photography.

Underwater Lighting. Both tungsten lamps and xenon gaseous discharge units have been described[65] as being used in a special torpedo-type camera for underwater photography. These units are so designed as to make it possible for the cameraman to photograph at considerable depth and into crevices and caves that would be difficult, or impossible, to illuminate under other conditions.

Carbon-Arc Follow-Spots. The Berlin-Tempelhof Studio developed a studio spotlight delivering 60,000 lm. The arc operates at 200 amp. A new type of triple-condenser is used with a fused-quartz lens nearest the arc. Projection lenses of different focal lengths permit a wide range of spot sizes.

A new type of carbon-arc follow-spot for studio set lighting was also designed by the Motion Picture Research Council. Especially coated optics filter the white light to match the tungsten balanced color-film sensitivity. This follow-spot provides 1000 ft-c in the center of a 10-ft diameter circle at 70 ft.

Low-Temperature Carbon Arcs. New low-temperature carbons that were being tested by the National Carbon Co. and the Carbone Lorraine Co., would provide the spectral energy distribution required for the present 3300 K color motion-picture films. This development should approximately double the photographic effectiveness of the carbon-arc lamp without increased power input. It will also be useful in background projectors, eliminating the corrective filters now used to correct 5900 K to 3300 K.

Studio Construction Materials

The trend toward lightweight set-construction materials continues. Molds up to 20 × 20 ft are cast in one operation from a single mold and may have the random surface textures of rough concrete or adobe or the typical appearance of brick or stone facings. The large molds are made of dense, highly calcined casing plaster or vinyl hot melt where flexible molds are needed. Large walls are cast from plaster reinforced with two layers of lightweight cloth (Paramount) or polyester resins reinforced with Fiberglas cloth (Universal). The weight of either type is three to six times less than that of conventional plaster cast.

Props are frequently made of plastic or resinous materials. Vinyl plastisols and cellulose acetate butyrate hot melts are employed in casting and slush-molding various objects (Twentieth Century-Fox, Columbia, RKO).

Polystyrene resins of low molecular weight have become a preferred material for casting transparent breakaway props in imitation of glass (Republic, Warner, M-G-M, Fox).[66] Thermoplastic sheets are being used in specially designed equipment to heat-form lightweight props in plaster molds through application of vacuum or compressed air. This method was found particularly adaptable to the fabrication of armor (Universal, M-G-M). A newly developed special pigment binder[67] has replaced the traditional glue size in water-base paints for the painting of scenic backings (M-G-M, Warner). The new binder produces superior results and eliminates in particular the continuous heating that glue-size paints require to prevent gelling.

A new lightweight snow material[68] for set dressing which consists of Perlite coated with calcium chloride was introduced (M-G-M, Universal).

Shredded Styrofoam of controlled particle size has been successfully employed for falling-snow effects (Paramount, RKO, Warner).

Use of stabilized aerosol foams,[69] for falling and dress snow effects, applied with specially designed foam generators and ejectors, has been perfected, particularly for outdoor sets (Universal, Warner, Republic, RKO).

Studio Equipment — Miscellaneous

Universal-International has developed a portable electric fog machine, which is small in size and light in weight, and which operates independently as a fog gun without such hindrances as air hoses and electric fans.

The largest camera crane in Hollywood was completed by Ralph Chapman. Electric motors are used for soundstage purposes and a gasoline motor for highway travel and exterior shots.

A combination 16/35mm animation stand, using an Oxberry/35 camera, was installed by the Motion Picture Division of Rapid, Grip & Batten, Ltd., in Toronto in cooperation with the Animation Equipment Co. of New Rochelle, N.Y.

An animation plotting device[70] was developed by the National Film Board of Canada.

In Australia the Pagewood Studios were reopened with new cameras, lighting and magnetic recording and re-recording facilities. A new cutting block is under construction, a small stage was completed and two more are in the course of construction.

Scientific Photography

Askania-Werke, Berlin, has developed special equipment for scientific motion-picture photography. With one of their cameras, Dr. Reick[71] of the Scientific Research Film Institute in Göttingen has made interesting motion-picture studies with infrared film of the strange life of fish and mice in absolute darkness.

A new type of daylight stop-motion drive for this camera has also been developed.[72]

Stereoscopic Photography

Interest in 3-D motion-picture photography declined during 1954, and no feature pictures were in production at the end of the year. Development of "single-film" systems continued whereby both pictures of each stereoscopic pair are printed upon the same film. In order to avoid rotation of the images, two pictures are printed, one above the other, on the same frame in the Bernier Naturama system, and by separating them far enough, two essentially separate optical systems can be used, as in the Stereo-Color system. With such arrangements the pictures naturally have a high ratio of width to height, giving them aspects quite suitable for wide-screen projection.

In January 1954, Technicolor Motion Picture Corp. was granted a license by Polaroid Corp. to process the latter's Vectograph motion-picture film. The two companies have worked steadily on the development of a commercial process during the past year. Substantial progress has been made, but because of difficulties greater than originally visualized, a commercial product is not yet available and the program is continuing.

Most of the distortions perceived in stereoscopic pictures are caused by false perspective.[73] False perspective cannot be corrected by variation of the camera interaxial separation. Parallax movements, which result from head movements in ordinary experience, are lacking in stereoscopic pictures and are replaced by perverse twists of the scene. This lack is felt as a real shortcoming of stereoscopic motion pictures and is best masked by frequent movement of the camera during shots.

16MM Prints and Projection

For making 16mm black-and-white release from a color original, a panchromatic fine-grain master positive is made from the original color negative. A 16-mm color positive is likewise made A&B in a color reduction optical printer from the original color negative. Another

technique developed this year is in the blowup of 16mm kodachrome original to Eastman color camera negative, inserting the effects by the A&B method into the 35mm negative. The 35mm color negative is then reduction printed to 16mm color positive. This technique is used only to replace the present technique of making 16mm Kodachrome masters for multiple prints when the original Kodachrome is not available or is to be recut for another picture. The reduction print to Eastman Kodak color positive from the 35mm color master negative is of better quality than Kodachrome prints from the 16mm Kodachrome master.

A satisfactorily bright and steady image of large size can be obtained from the projection of a 16mm print[74] if good film, a good camera, a good printer and a good projector are used. It has been shown by a trade survey that 16mm prints differ appreciably in steadiness. This was learned by viewing prints made in various laboratories from a 16mm reversal original, or from a 35mm negative made from the same scene. The steadiness of some prints approached the quality of the 16mm original, as was found by the examination of the prints made especially for this survey. It was also noticed that the photographic quality of the prints varied over a wide range, comparable to the observed variation in steadiness.

An experimental model of a 16mm projector is described[75] in which air pressure is used to effect pulldown of the film. Some results of speed tests for this type of pulldown are discussed.

A xenon-arc, high-pressure xenon-gas quartz lamp was incorporated into the design of the Armed Forces AQ-2(1) 16-mm sound projector. The pulsed-light operation of the projector results in shutterless operation with five light interruptions (pulses) per frame at 24 frames/sec.[76]

DeVry Corp. introduced a shutterless cine projection system based on a xenon-filled quartz bulb enclosing a pair of electrodes that provide intermittent light fields and eliminate the need for a shutter.

TV Broadcasting — Equipment and Methods

Studio Development. One major improvement in the field of television broadcasting was the addition of new and more elaborate studio facilities in both New York City and Hollywood. The new studio facilities included new lighting and equipment techniques, and much thought was extended toward the possibility of color-television broadcasting, when required.

The new studio development resulted in new types of studio and control equipment being brought into use. Lighting control consoles were found to be necessary, so as to afford proper lighting for color-television broadcasting, and it was decided to employ large incandescent lamps in the studio installations. Of particular interest was the Lumitron-Magnalite lighting control system employed in an NBC color TV studio installed in Brooklyn.

The construction and general development of the new CBS TV Color Theater in New York City was of particular interest to engineers. It is an air-conditioned studio with a working stage area comprising over 5000 ft. More than 500 stage lighting fixtures are employed.

Transmitter Development. Of particular interest was the addition of new VHF and UHF transmitters in the broadcasting field. At the end of the year 1954 a great number of new stations had been granted licenses by the Federal Communications Commission. Many of them installed higher powered VHF transmitters. A few of the new transmitters were of the UHF type. Propagation at the UHF frequencies was not found to be entirely satisfactory, many losses having developed in the field owing to the presence of trees, buildings, and surrounding absorption or other signal reduction attributes.

Of particular interest were the new 50-kw VHF transmitters installed by some of the operating broadcasters in television, which served to increase their operating power and thereby increased their effective service areas and provided much better coverage of listeners. There were no unusual technical developments in the new transmitters, the circuits employed resembling those already in use throughout the field.

Color Cameras. RCA's new "3-V" camera for televising color motion-picture and slide films uses three vidicon pickup tubes. An optical multiplexer consisting of two dichroic mirrors and a filter direct the red, blue and green components into the various vidicon pickup systems.[77]

Set Lighting. Television set lighting for color and black-and-white live shows[78,79] has settled down to a modified form of motion-picture studio set lighting of the type that is illuminated almost entirely by incandescent tungsten bulbs. More attention is being given to modeling and other techniques for better light separation and depth effects.

Color television set lighting comes largely from incandescent tungsten bulbs,[80,81] with carbon-arc lamps filtered to the color temperature of the incandescent bulb for use in special effects and process projection.

Film Reproduction for TV. Many TV companies are now shooting in 35mm color negative and releasing in black-and-white as well as color.

The A&B printing technique has been used extensively this past year by TV companies to cut costs of making color internegatives. The 35mm color negative is cut A&B, and the lap dissolves and fades are made in a contact printer, directly from the original negatives as the color print is made, by the use of a fading device on the release printer.

For television film reproduction it appears that the long-used iconoscope is on the way to rapid obsolescence with the development of two different but nevertheless effective approaches to the problem of film reproduction. One approach is based on the use of the vidicon tube and intermittent projectors, and the other approach employs the flying-spot scanner and continuous-motion projectors. Rapid progress has taken place in the adoption of the vidicon tube for both monochrome and color television film reproduction.[82,83,84] Monochrome vidicon film cameras and associated equipment became commercially available during 1954 and found enthusiastic acceptance in many television stations. The Eastman Kodak Co. announced a modification of their Model 250 16mm television projector to permit its use on a partial storage basis.[85]

The RCA Model TK-26-A color film camera, Fig. 25, employs three matched vidicon tubes illuminated through dichroic mirrors. An optical multiplexer unit now available permits two 35mm or 16mm projectors and one slide projector to work into one color film camera. Modifications of a 35mm projector include substitution of an incandescent lamphouse and shutter for the pulsed-light source used for monochrome iconoscope reproduction.[86]

The Philco and Dumont flying-spot scanners, first announced in 1953,[87] have in 1954 undergone modifications to improve their performance, particularly as applied to color film reproduction for color television.[88] The Eastman Kodak Co. announced development of a unique compensator consisting of two rotating and tilting mirrors.[89] This projector mechanism will be incorporated into a flying-spot scanner being developed by the General Electric Co.

Kinescope Recording. The most notable development in the field of kinescope recording was the experimental work of Goodale at NBC in recording color television on subtractive color film stocks.[90] A triniscope monitor was employed, utilizing a separate 10-in. kinescope for each of the three colors, red, blue and green. The three colored images were then optically combined by means of mirrors and simultaneously recorded on 35mm color negative film, using a conventional kinescope recording camera. Normal color film development and

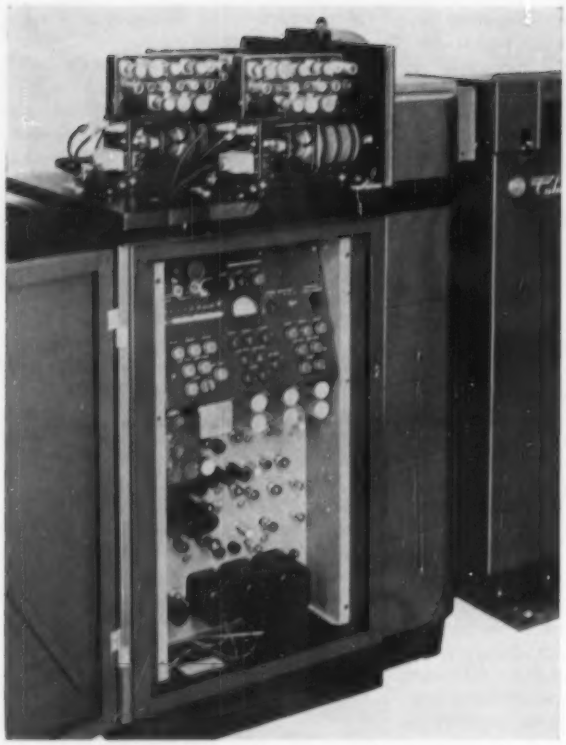

Fig. 25. RCA TK-26-A 3-vidicon color film camera showing vidicon sub-chassis and local control panel.

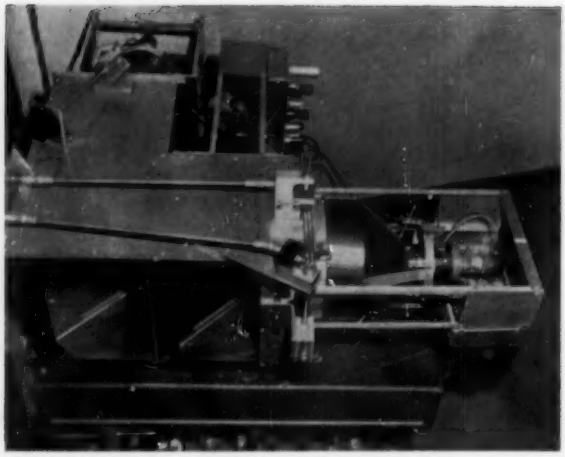

Fig. 26. NBC experimental triniscope monitor for color kinescope recording.

printing followed, producing a reasonable facsimile of the original live color television image (Fig. 26).

Several proposals were advanced for recording color television images on black-and-white film by means of spectral separation and area sharing.[91]

The Producers Service Co. of Burbank, Calif., has built a kinescope recording truck for monochrome location recording. Equipment includes a kinephoto monitor, provision for either 35mm or 16mm kinescope recording camera, 16½mm synchronous magnetic sound recorder and other associated electronic equipment. When the truck is used in conjunction with a standard television mobile unit, a complete program recording can be made on location.

At year's end it was announced that a firm bearing the name High Definition Electronic Picture Recording System, Inc., had been formed in Los Angeles to use the equipment and techniques developed by High Definition Film, Ltd., of London,[92] to produce film programs for television in the United States or elsewhere. It is expected that the Los Angeles plant will be ready for operation about September 1955.

Camera Cradle. The Houston-Fearless Corp. introduced two new cradle heads, one for monochrome TV cameras and the other for the RCA color cameras. The degree of tilt ranges from 30° down, to 30° up with adjustable tilt drag. The camera can be balanced by moving the camera plate forward or back, a lead screw maintaining absolute balance at all times.

Slide Projector. The Gray Research & Development Co. introduced the Gray 3-B single-lens Telojector for television projection of 35mm slides. This projector, which is equipped with either a 6-in. or a 7½-in. projection lens, will accommodate a total of 12 slides.[77]

Projection TV

A compact transportable projection TV unit presenting a 9 × 12-ft picture of good brightness has been introduced by General Precision Laboratory Inc. Designated as Model PB 610, this unit consists of a short, cabinet type of rack on top of which is mounted a 12-in. Schmidt optical barrel. An RF voltage tripler supplies 37 kv for the 5-in. projection tube.

RCA introduced a 5-in. projection tube, Type 5AZP4, (Experimental No. C73394-A). This tube is similar to the 5TP4, but has the added advantages of higher brightness and smaller spot size due in part to the higher operating voltage, 40,000 for the 5AZP4, 27,000 for the 5TP4.

Fleetwood Corp., Toledo, Ohio, has announced their model FL 1000. This unit uses 14-in. Schmidt optics and the RCA 5AZP4, the tube being air cooled. Deliveries were promised by 1955.

Closed-circuit or network television made money during 1954. The closed circuits carried both paid entertainment and sales programs.

The Marciano fight paid well, in spite of the loss of some ticket sales due to postponement.

Eidophor. During 1954 the first commercial prototype of the Eidophor large-screen color television projector was assembled in the New York Laboratories of Twentieth Century-Fox Film Corp. This model, of the field-sequential type, was built cooperatively by the General Electric Co. and Dr. Edgar Gretener A.G. of Zurich, Switzerland. Both the projector and improved studio equipment are being critically studied, tested and prepared for demonstration.

TV Remote Pickup Equipment

Mobile Video Recording Units. A recent addition to the remote pickup facilities is a self-sufficient video recording mobile unit. This equipment is being used on location for closed-circuit video recording films and for recording remote telecasts, thus by-passing special circuits to permanent video recording installations, thereby reducing costs and improving recorded picture quality. A typical unit of the Television Recording Service of Hollywood is shown in Fig. 27; it employs a Producers Service 16mm magnetic sound recording equipment. Figure 28 is a close-up of the video and sound equipment.

High-Power 7000-mc Relay Equipment. Considerable improvement was made in 1954 in remote broadcast microwave relay equipment on the 7000-mc band, which is most commonly used for television remote broadcast relaying. New

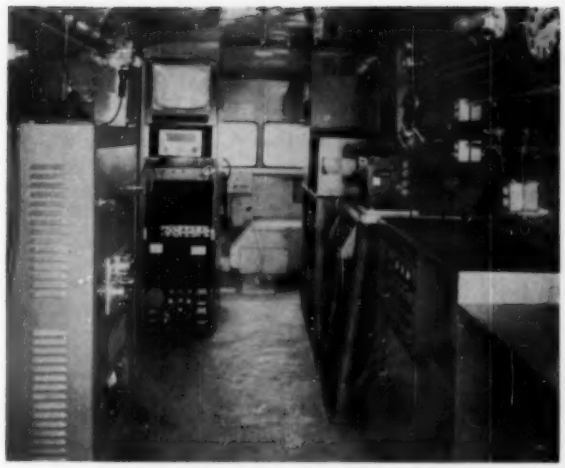

Fig. 27. Television Recording Service mobile, video and sound recording unit.

Fig. 28. Television Recording Service mobile, video and sound recording unit: interior close-up of recording equipment.

equipments introduced have up to 10-mc bandwidth and 10 times the radiated power of older equipments. This has served to improve picture quality, extend the range of remote pickups and facilitate sub-carrier sound channel operation. An example is the Philco Model TLR-3 color television relay equipment whose transmitter head is shown in Fig. 29.

Color Mobile Units. This development was not entirely new in 1954, but several stations have added complete color remote telecasting trucks to their facilities. These units are far more elaborate than the black-and-white units because of the amount and complexity of equipment necessary to produce the color telecasts.

Radio Communication Facilities. Many stations have increased the radio communication facilities employed on their TV remote mobile units. The 26-mc, 52-mc and the 450-mc bands are used for coordination and program audio channels. The use of these facilities has resulted in decreased line charges and reduction in setup time of remote telecasts. Several hundred equipments using frequency modulation are now in regular use.

Remote Microwave Relay Sound Diplexing Equipment. Several manufacturers introduced new high-quality sub-carrier sound diplexing equipment whose function allows transmission and reception of broadcast quality audio sound signals in conjunction with television video monochrome or color picture signals over a microwave transmitter receiver system used for remote television broadcast relaying. This process has been accomplished with negligible interference of signals, resulting in excellent sound with no picture interference. It has been particularly helpful in simplifying multihope remote relay broadcasts, because once the picture channel has been lined up, the program sound is automatically carried through.

TV Networks

Forward Strides in Color, Black-and-White Television.[90] About 20,000 channel-miles of TV facilities — 1800 coaxial cable and 18,000 radio relay — were added during 1954, bringing the total to about 69,000 (Fig. 30). Joined to the network last year were about 100 TV stations in some 70 cities, extending network service to about 360 stations in more than 230 cities. Also during the year, over 47,000 channel-miles of cross-country routes — about 11,000 coaxial cable and 38,000 radio relay — were re-engineered and re-equipped to carry color to 140 television stations in 101 cities.

Coaxial Cable Conversion to Color Operation. For color transmission on the type of coaxial facilities regularly used for some years for monochrome service, additional attenuation and phase equalizers to give a flatter overall response have been provided. Converters have been installed that translate the 3.6-mc color sub-carrier to 2.6 mc on the coaxial facilities[94]; the luminance bandwidth is restricted to approximately 2 mc. Converters of this type are equipped with automatic switches that recognize the presence of the color sub-carrier and change the associated terminals from monochrome to color condition when required.

L3 Coaxial. Some of the older coaxial routes have been converted for operation of a wider band system known as L3 by a complete substitution of new amplifying and power equipment, plus shortening the average spacing of amplifiers from about 8 miles to about 4 miles.[95] The system transmits a bandwidth in excess of 8 mc. When used for television, 600 message circuits may be operated in the lower frequency range, the television channel occupying the range from about 4 mc on up. New types of phase and attenuation equalizers have been employed that simplify adjusting and maintaining the system in operating condition. The accompanying map (Fig. 30) shows those TV routes which have been and which will be constructed or converted for L3 operation in the next few years.

Long-Haul Microwave Color Conversion. In order to transmit successfully television signals according to NTSC requirements on the long-haul TD2 microwave systems, major problems of differential gain and differential phase had to be solved.[96] Differential phase and differential gain refer to differences in phase

Fig. 29. Philco Model TLR3 color television relay transmitter head with 4-ft antenna.

Fig. 30. Bell System television network routes, color and monochrome.

or gain of a signal transmitted at the color sub-carrier frequency, as its average level is varied from blanking to white. A major improvement was obtained by pre-emphasizing the transmitted video signal so that low frequencies, where the maximum energy occurs, are attenuated relative to the highs, thus minimizing the average FM swing of the microwave system. This also improves differential gain problems by driving associated amplifiers at lower peak levels. Additional decrease in differential phase is obtained by envelope delay networks installed in the IF portion of the system, as required. Additional attenuation equalizers and other improvements have been provided to ensure a flat frequency response for these facilities.

Microwave Automatic Switch. The multiple-unit automatic switch (MUAS) rapidly substitutes a protection channel on a TD2 microwave system for any one of five regular channels during periods of excessive fading or other interruptions. Since the vast majority of fading encountered in practice is selective with frequency, not affecting all channels at the same time, one protection channel can handle the requirements of several working channels. Switching is initiated when noise on the working channel exceeds a prescribed limit or when loss of continuity occurs. When a channel failure occurs, if noise and continuity on the protection channel are satisfactory, a signal is sent over a wire line facility to the transmitting end of the section where it operates a switch to feed the protection channel in parallel with the regular channel. Immediately thereafter a switch at the receiving terminal restores the failed service. The service is returned to the normal channel automatically when it becomes satisfactory. When a radio fade occurs, the service is switched to the protection line in 1/30 sec or less. The switch is generally made before the fade has caused unsatisfactory picture transmission.

Horn Reflector Antenna. New so-called horn reflector antennas were being installed late in 1954 on new long-haul (TD2) microwave routes (Fig. 31). This antenna replaces the delay-lens antennas used on existing TD2 routes, permitting broader frequency application. The new antenna will simultaneously handle frequencies from 4000 mc to approximately 11,000 mc, with effective forward gains of about 40 to 50 db, depending on frequency and polarization. Coupling to this antenna is by means of a circular waveguide rather than the rectangular waveguide currently in use, permitting simultaneous use of both horizontal and vertical polarization. The use of different polarizations by various groups of channels will assist in reducing interference between them. Directivity discrimination is improved. The antenna itself consists of a parabolic reflector constructed integrally with a feed horn as shown in Fig. 31. Overall dimensions are about 20 × 10 ft.

Television Operating Centers. To meet the increasing demand for flexibility of connections between intercity and intracity television facilities and to improve the performance of the resulting tandem transmission paths, the Bell Telephone Laboratories have developed new low-impedance video switching and associated switching control equipment. Installations in Bell System television operating centers, where switching and service adjustments to facilities are made, will permit full switching flexibility of video transmission facilities on a relay-operated basis, using the latest components and techniques available for this purpose. The new switching plan requires extensive television operating center re-

arrangements to accommodate the many new features that are designed to maintain the through-circuit transmission characteristics to very close limits. Large offices such as New York, Chicago and Los Angeles, where the switching requirement is the severest, will be the first locations to receive the new installations.

Cable Video Transmission System. First installations were made of the new A2A video transmission system equipment, designed to improve transmission of television signals over polyethylene-insulated cable pairs used for intracity connections. Among the advantages of the new system are: a wider and flatter gain-frequency response, ability to meet NTSC color transmission requirements, increased stability and reliability, decrease in number of amplifiers required for a given distance, increased flexibility of equipment, reduced effect of seasonal temperature variations, in-socket filament activity testing, reduced microphonics, reduced heating and reduced power-supply maintenance.

Test Methods. In order to transmit saturation and hue information properly using NTSC color television standards, differential phase and gain at the color carrier frequency must be held to a minimum on the transmission facilities. A system to measure differential phase and gain, known as the 47A transmission measuring system, developed by the Bell Telephone Laboratories, has now been applied to Bell System test methods on color television services. The new system includes a transmitter for signals which simulate a color television signal, and a receiver to examine the output of the facility being measured, using an external oscilloscope as an indicating device. The transmitter and receiver operate as independent units and are packaged as portable instruments.

"Pay-As-You-See" TV

During the first half of 1954, International Telemeter Corp. operated an experimental, wired, "pay-as-you-see" television system in Palm Springs, Calif. The Telemeter subscriber sees a scrambled picture and hears a barker announcing the program and its price until he deposits the correct amount in his coin box (Fig. 32), then the picture and sound are presented "clear." The program price, which is controllable from the transmitter, is also displayed in a window on the coin box. The average Palm Springs subscriber bought 40% of all the entertainment offered him, in direct competition with three free channels, including two major networks. During the latter part of 1954 a new Telemeter receiver unit was demonstrated and a series of tests of air-link Telemeter were conducted in the Los Angeles area.

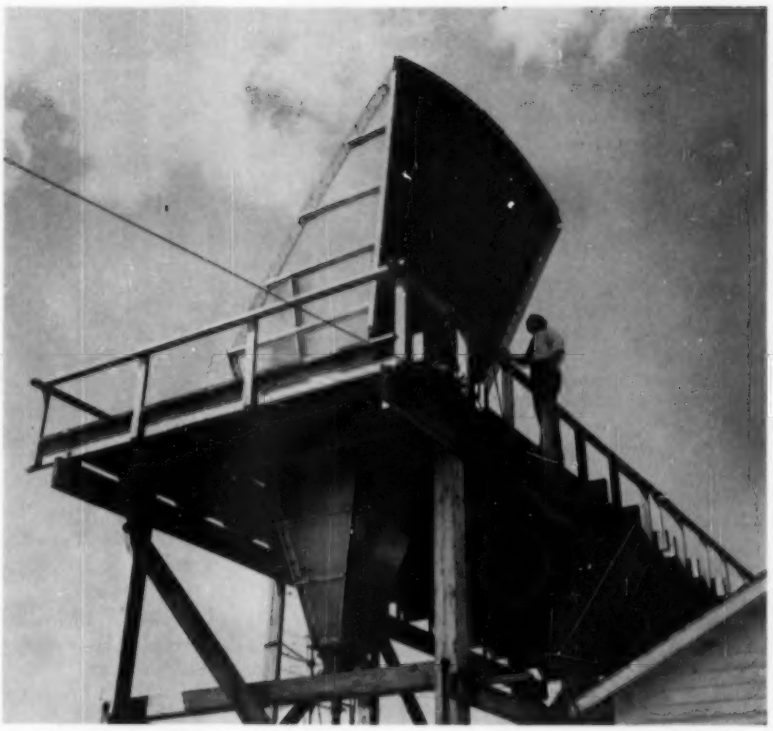

Fig. 31. Horn reflector antenna for television microwave-radio systems operating in the range of 4000 to 11,000 mc.

Electronic Photography

Both RCA and Bing Crosby Enterprises were known to be continuing development of "video tape" recording, a system whereby television pictures, sound and synchronizing pulses will be simultaneously recorded on a single strip of magnetic tape. Indications were that progress was being made, but neither company had as yet announced a commercially available unit for broadcast use.

Eurovision

In June 1954 eight countries in Europe linked up for an exchange of TV programs (Fig. 33). Pictures originating in Rome, for example, using a radio link across the Alps, were clearly seen in Great Britain. The highest relay station at 12,000 ft is located on the east side of the Jungfrau in Switzerland[97] (Fig. 34).

Three different TV standards are used in Europe: 405 in Great Britain, 625 in most European countries and 819 in France and a part of Belgium. To convert from one standard to another, a TV camera scans the picture[97] on a TV receiver (Fig. 35).

TV Programming—Foreign

British. The TV service of the British Broadcasting Company now transmits approximately 40 hr of programs per week, using many locations and rebroadcasting from the continent of Europe. Approximately 95% of the population is now reached; there is an average of 4½ million viewers per night. Most of the programming originates from four studios at Lime Grove, Shepherd's Bush. The present main transmitter in London at Alexandra Palace will shortly be moved to the Crystal Palace site. The film companies shoot about 75,000 ft of film per month. BBC added four TV transmitters as follows: Isle of Wight; N. Hessary Tor, Devon; Aberdeen, Scotland; and Norwich, E. Anglia. More than one in every four households in the United Kingdom had TV sets at the end of 1954, approximately 4,307,772 sets being in use.

A number of developments by the BBC in television studio equipment, including apparatus for reproducing film and re-

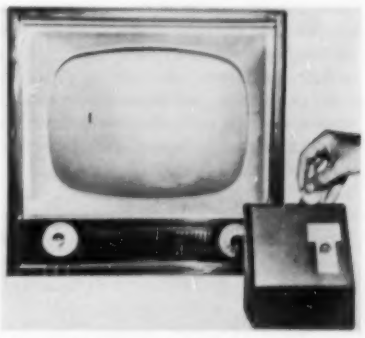

Fig. 32. "Pay-as-you see" telemeter system.

Fig. 33. Television network of Western Europe.

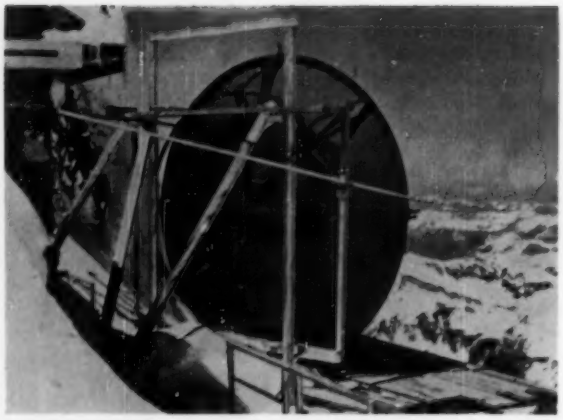

Fig. 34. Television relay on Jungfrau in Switzerland, elevation 12,000 ft.

cording TV programs on film, have been described.[99]

Color TV[100] is being investigated in Great Britain by the BBC, EMI and Marconi. The NTSC system converted to the British TV standard of 405 lines, and other color TV systems were demonstrated on several occasions.

European. A 600-ft high TV tower is being completed in Stuttgart, Germany. At the top of the tower is located a restaurant, in addition to the TV and and FM transmitters and relay stations. An interesting design of a German TV network relay tower is shown in Fig. 36.

In France the tendency is to shoot television film on 16mm reversal black-and-white; Kodachrome is planned for the near future.

The sale of TV receivers is improving in Eastern Holland because of good reception from Germany, France and Belgium. Reception is generally poor in the western part of Holland.

Canadian and Australian. In Canada there has been a considerable increase in the production of TV commercials and short subjects. The Miridon Productions Corp. Ltd. devised a method of prelighting sets by mounting lights on a mobile platform.

In Australia, television broadcasting does not yet exist, although there has been extensive planning with regard to standards and frequency allocations. It is hoped that service will be undertaken during 1955.

High-Speed Photography

The year's progress in high-speed photography was highlighted by the Second International Symposium on High-Speed Photography, held in Paris from September 22 to 28. More than 300 of the world's leading workers in this field gathered to hear five formal lectures and 66 papers, all of which will be published during 1955 in French, English and German.

Preliminary reports on the Symposium include those by Naslin[101] and Sultanoff.[102] The high degree of interest shown in the first two symposia has resulted in the formation of a continuing organization to plan and coordinate future meetings on a biennial basis. The Third Symposium is scheduled for the spring of 1956 in England, with succeeding meetings in Germany and the United States.

Several papers further describing characteristics and applications of electronic flashlamps appeared during 1954, including studies of light measurement by Edgerton, Bonazoli and Lamb,[103] and by Stamp and Coghlan.[104] Parker[105] provided a general review of this subject, and Rockwood and Harvey[106] described their method for triggering a lamp by monitoring the movement of teeth on a Fastax sprocket. Rockwood and Kuniyuki[107] outlined an application of multiple flashing to time-motion measurement, and Merritt[108] described equipments and techniques employed in ballistics measurements at the U.S. Naval Proving Ground, Dahlgren, Va.

Further work in Kerr-cell shutters was reported by Sultanoff[109] and Heine-Geldern,[110] and additional rotating-mirror cameras were noted from Beckman & Whitley, Inc.[111] and from the Los Alamos Scientific Laboratory.[112] The Beckman & Whitley cameras obtain 25 images on 35mm film at rates of 1.3 million/sec for Model 189 and 2.4 million/sec for Model 222. The focal length of the objective lens is 24 in., with a maximum *f* stop of 14.5 (Figs. 37 and 38). The Los Alamos instrument, designated Model 8, obtains 96 images at a rate of 15 million/sec.

The use of clouds of magnesium

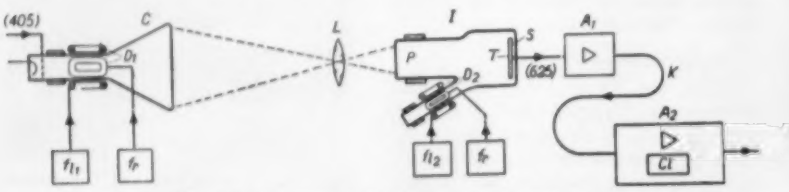

Fig. 35. European television converter system.

Fig. 36. German TV network relay tower

Fig. 37. Beckman & Whitley super high-speed camera and control console.

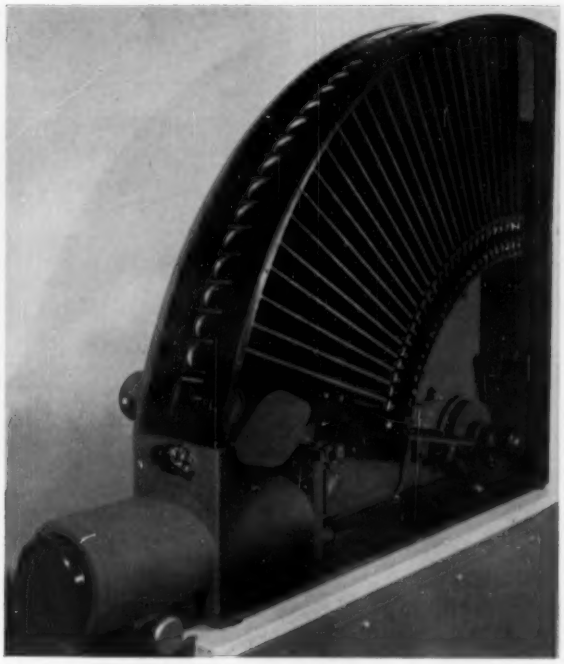

Fig. 38. Beckman & Whitley super high-speed camera close-up.

powder that are ignited in air as a source of high-intensity illumination was described by Clarke, Dawson and Wadman.[113]

An interesting paper by Lipton[114] outlined the characteristics of a new type of tracking telescope used in guided-missile instrumentation at White Sands Proving Ground, N.M. Another paper pertaining to ballistics instrumentation at White Sands described a continuous processor for 5¼-in. film, as is used in the Bowen ribbon-frame cameras and other instruments.[115] Design considerations are generally similar to the U.S. Naval Ordnance Test Station 12-in. continuous processing machine previously reported in this *Journal*.[116]

The excellent digest service "Technicalia Photographica" of *Photographic Engineering* has continued to expand in scope and has yielded many valuable references to papers on high-speed photography, including several given during the Fourth International Symposium on Combustion.[117]

Responses of some emulsions to very short exposure times were further examined in a paper by Castle.[118]

General publications of interest included Volume 5 of *High-Speed Photography* published by SMPTE and a series of articles in *Industrial Laboratories* by John H. and Jennie W. Waddell. Titled "Photographic Motion Analysis," these well-illustrated chapters will soon be combined in a book of the same name, probably available during 1955.

Although publication in the field appeared to be at somewhat less than the level prevailing in 1953, this may be due to the very high output of papers following the First International Symposium on High-Speed Photography in October 1952. It is anticipated that publication of the proceedings of the Second Symposium during 1955 will do much to increase the amount of information available in this area.

Mercury-Cadmium Light Source. A double lamp mercury-cadmium compact-source lighting unit[119] designed especially for high-speed photography is now available in this country (Fig. 39). It consists of two 1-kw mercury-cadmium arcs with suitable control equipment. The units, improved over the original design, are flashed at 3, 5 or 10 kw for 5, 2 or 1 sec.

Armed Forces

TV Applications. During the year 1954 the Signal Corps continued its developmental activities in the areas of tactical and training TV. In the tactical application of television, the Signal Corps tactical TV units participated in a number of tactical exercises and developed further procedures, techniques, and equipment directed toward making tactical television an integral part of battlefield communication systems.

Basic studies to determine the effectiveness of the use of television as a training medium were conducted during 1954 and the favorable results of these studies has led to a program for implementing this use of television on an Army-wide basis.

Considerable progress has been made in both equipment improvements and techniques for the use of television as a film production medium (kinescopes). As a result a new area of film subjects has been opened up within the Army, utilizing this medium. The Office of Armed Forces Information and Education, Department of Defense, has established a program of television broadcasts at certain isolated military bases. TV transmitters of very low power cover a sufficient area for the military population and their families. Television networks, with the consent of clients and agencies, have provided kinescope recordings and filmed programs, with commercials retained. These are augmented by industrial films, Armed Forces information films and features films from the motion-picture industry. Commanding officers have made effective use of the limited "live" television facilities. Stations are now in operation at Limestone Air Force Base, Maine; at Lajes Field, Azores; and at Wheelus Field, Lybia. Ten additional stations are planned for the coming year; they will include Sidi Slimane, French Morocco; Keflavik Airport, Iceland; and stations in Greenland, Newfoundland and the Pacific.

Training Films. The United States Air Force is producing a type of "nuts and bolts" film that satisfies a specific need for fast production of films pertinent to training and indoctrination of personnel. A mobile production crew, operating an Auricon single-system camera, consists of cameraman, soundman and writer-narrator. Editing is done almost entirely in the camera. Although the finished films are not of professional studio quality, they have proved to be highly satisfactory as classroom training aids, and they can be very rapidly produced at very low cost.

16mm Magnetic Film. The Material Laboratory, Navy Bureau of Ships, has made substantial progress in the de-

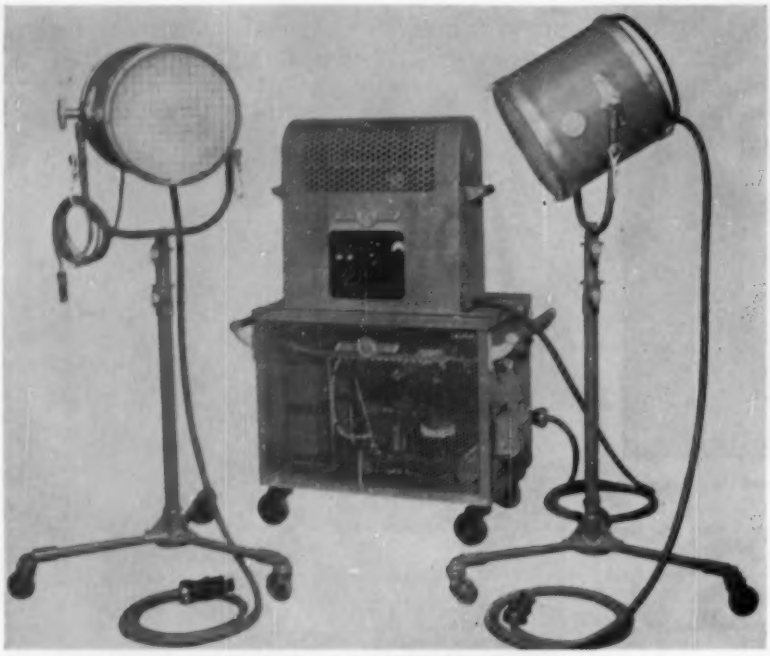

Fig. 39. Mole-Richardson Cine-Flash light source: double unit.

velopment of a method of measuring the magnetic strength on 16mm magnetic film soundtracks, by utilizing a non-magnetic loop for the determination of the absolute surface induction.

Conclusion

The above represents an incomplete but significant review of the progress during 1954 in motion-picture and television technology. The chairman of the committee wishes to express his thanks to the committee and to the many others who participated in submitting valuable contributions which made this report possible.

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References

1. Loren L. Ryder and Jack Bishop, "Vista-Vision moves forward," *Am. Cinem., 35:* 552, Nov. 1954.
2. Loren L. Ryder, "Paramount's Vista-Vision," *Intl. Projectionist, 29:* 5, 22, Apr. 1954.
3. E. I. Sponable, H. E. Bragg and L. D. Grignon, "Design considerations of CinemaScope film," *Jour. SMPTE, 63:* 1–4, July 1954.
4. Arthur Rowan, "Arriflex Camera adapted for CinemaScope," *Am. Cinem., 35:* 344, July 1954.
5. Leigh Allen, "FilmoRama-CinemaScope in 16mm," *Am. Cinem., 35:* 504, Oct. 1954.
6. Arthur Rowan, "Todd-AO in newest wide screen system," *Am. Cinem., 35:* 494, Aug. 1954.
7. R. H. Heacock, "Wide screens in drive-in theaters," *Jour. SMPTE, 64:* 86–87, Feb. 1955.
8. F. J. Kolb, Jr., and F. Urbach, "Temperature-sensitive phosphors for the evaluation of air jets designed to cool motion-picture film," *Jour. SMPTE, 62:* 364–376, May 1954.
9. *Projection Arc Lamp Review, Theater Catalog,* 256–262, 12th Ed., 1954–55. Jay Emanuel Publications, Inc., Philadelphia, Pa.
10. F. P. Holloway, R. M. Bushong and W. W. Lozier, "Recent developments in carbons for motion-picture projection," *Jour. SMPTE, 61:* 223–240, 1953.
11. James Morris, "The VistaVision Horizontal Projector," *Intl. Projectionist, 29:* 16–17, Oct. 1954.
12. "Die Xenon-Entladungslampe als Projectionslichtquelle," *Kinotechnik:* No. 10, 322–324, 1954.
13. Arthur E. Gavin, "Technical progress in 1954," *Am. Cinem., 36:* 24, Jan. 1955.
14. Arthur Rowan, "M-G-M's new underwater camera blimp," *Am. Cinem., 35:* 440, Sept. 1954.
15. Till Gabbani, "Hollywood's greatest underwater feature," *Am. Cinem., 35:* 282, June, 1954.
16. "Follow-focus attachment for Mitchell Camera," *Am. Cinem., 35:* 237, May 1954.
17. Allen L. Sorem, "The effect of camera exposure on the tone-reproduction quality of motion pictures," *Jour. SMPTE, 62:* 24–44, Jan. 1954.
18. John D. Hayes, "CinemaScope camera lenses" (abs.), *Jour. SMPTE, 63:* 122, Sept. 1954.
19. Motion Picture Research Council Bulletin RC-1-P, No. 20.
20. Mark Stevens, "The New Kollmorgen *f*/1.7 Lens," *Intl. Projectionist, 29:* 12–14, Oct. 1954.
21. *Intl. Projectionist, 29:* 22, May 1954.
22. *Intl. Projectionist, 29:* 10, July 1954.
23. *Intl. Projectionist, 29:* 23, Nov. 1954.
24. *Intl. Projectionist, 29:* 26, Aug. 1954.
25. *U.S. Camera,* 103, Feb. 1954.
26. *Am. Cinem., 35:* 598, Dec. 1954.
27. "Vistascope wide screen system uses one double purpose lens," *Photo Trade News,* 106, Nov. 1954.
28. *Jour. SMPTE, 63:* 263, Mar. 1954.
29. *Jour. SMPTE, 63:* 212, Nov. 1954.
30. "A new instrument for checking the focus of camera-mounted lenses," *Am. Cinem., 35:* 129, Mar. 1954.
31. John Hoke, "Adapting the Zoomar Lens to the Auricon-Pro," *Am. Cinem., 36:* 28, Jan. 1955.
32. Jerome W. Stafford, "Electronic comparator for the automatic inspection of magnetic sound prints," *Jour. SMPTE, 64:* 137–139, Mar. 1955.
33. "Magnetic head wear," Panel Discussion, *Jour. SMPTE, 62:* 238, Mar. 1954.
34. Werner Jahn and Josef Zinnecker, "Ein Tonfilm-Aufnahmewagen für Spielfilm-Aussenaufnahmen," *Kinotechnik:* No. 8, 242–245, 1954.
35. Hans Friess, "Die Aufnahme, Wiedergabe und Bearbeitung von Bild- und Tonfilmen in Fernsehbetrieb," *Fernmeldetechnische Zeit.,* Heft 7/1954.
36. O. Buhler, "Ein neues Mischpult für stereophonische Tonaufnahmen in der Filmtechnik," *Kinotechnik:* No. 11, 346–348, 1954.
37. Arthur Rescher, "Laminated magnetic sound tracks for 16mm films," *Am. Cinem., 36:* 154–155, Mar. 1955.
38. "Perutz sorgt für gleichmässige Umkehrentwicklung," *Kinotechnik:* No. 6, 170, 1953.
39. *J. Appl. Phys., 24:* 1495–1513, Dec. 1953.
40. Kenneth M. Carey, "Latensification of multilayer color film," *Jour. SMPTE, 63:* 61–63, Aug. 1954.
41. *Instr. Photo. 26:* 5, May 1954.
42. W. Hanson and W. Brewer, "Subtractive color photography: the role of masks," *J. Opt. Soc. Am., 44:* 129–134, Feb. 1954.
43. C. Anderson, C. Osborne, F. Richey and W. Swift, "Sensitometry of the color internegative process," *Jour. SMPTE, 63:* 143–146, Oct. 1954.
44. R. C. Lovick and R. L. White, "Factors affecting application of soundtrack developers to color films," *Jour. SMPTE, 63:* 188–190, Nov. 1954.
45. H. F. Ott and R. C. Lovick, "High-efficiency air squeegee and sound track developer applicator for color films," *Jour. SMPTE, 63:* 191–194, Nov. 1954.
46. R. K. Letzer and S. A. Powers, "Interference filters for photographic densitometry," *J. Opt. Soc. Am., 44:* 870–874, Nov. 1954.
47. John G. Frayne and J. Howard Jacobs, "Densitometers for control of color motion-picture film processing," *Jour. SMPTE, 64:* 67–71, Feb. 1955.

48. Harry G. Morse, Monroe H. Sweet and Eugene F. Berley, "An automatic recording color densitometer," *Instrumentation, 7:* No. 5, 28–29, 4th quarter, 1954.

49a. W. L. Brewer and F. C. Williams, "Definitions and basic concepts," *J. Opt. Soc. Am., 44:* 460, June 1954.

49b. R. H. Morris and J. H. Morrissey, "Determination of primary equivalent neutral densities," *J. Opt. Soc. Am., 44:* 530, July 1954.

49c. F. H. Holland, R. S. Mickelson and S. A. Powers, "Densitometer calibrations," *J. Opt. Soc. Am., 44:* 534, July 1954.

50. W. R. J. Brown, "A rapid-scanning microdensitometer," *Jour. SMPTE, 63:* 147–150, Oct. 1954.

51. O. E. Miller, "Sensitometers for color films," presented at 76th SMPTE Convention, Oct. 22, 1954.

52. W. Lyle Brewer and Stanley A. Powers, "Color densitometers: performance characteristics," presented at 76th SMPTE Convention, Oct. 22, 1954.

53. Murray C. Goddard and Stanley A. Powers, "Color densitometers: control methods," presented at 76th SMPTE Convention, Oct. 22, 1954.

54. *Jour. SMPTE, 62:* 98, Jan. 1954.

55. A. J. Sant, M. C. Goddard and O. E. Miller, "A light meter for printer control," *Jour. SMPTE, 64:* 123–125, Mar. 1955.

56. A. M. Koerner, "The problems of control of the color photographic process," *Jour. SMPTE, 63:* 225–230, Dec. 1954.

57. R. C. Lovick and R. L. White, "Factors affecting application of soundtrack developers to color films," *Jour. SMPTE, 63:* 188–191, Dec. 1954.

58. V. C. Chambers and W. R. Holm, "A method for splicing motion-picture film," *Jour. SMPTE, 64:* 5–7, Jan. 1955.

59. W. R. Holm, "Splicing motion picture film with tape," *Am. Cinem., 36:* 151, Mar. 1955.

60. D. E. Grant and H. F. Ott, "A rapid automatic stitch splicer for darkroom operation," *Jour. SMPTE, 63:* 194–196, Nov. 1954.

61. A. Rasch and J. I. Crabtree, "Development of motion-picture positive film by vanadous ion," *Jour. SMPTE, 62:* 1–10, Jan. 1954.

62. A. Rasch and J. I. Crabtree, "An inorganic developer reactivated by electrolysis," *Phot. Sci. & Tech., Series II, Vol. 1:* 59–67, May 1954.

63. R. Henn and J. L. Crabtree, "A reference scale for hypo determination in film with acid silver nitrate," *Phot. Sci. & Tech., Series II, Vol. 1:* 83–84, May 1954.

64. John Forbes, "Sensitoflex—new photometric exposure measuring device," *Am. Cinem., 35:* 396, Aug. 1954.

65. Dimitri Rebikoff, "Underwater color cinematography," *Jour. SMPTE, 63:* 55–60, Aug. 1954.

66. Motion Picture Research Council Bulletins:
"New Resin for Breakaway Glass," 58.276-A, 5-12-49.
"Dow Chemical Polystyrene Resins as Breakaway Glass," 58.276-B, 1-18-51.
"PS*1 Resin for Breakaway Glass," 58.276-C, 7-18-51.
"Modified Polystyrene Resins as Breakaway Glass," 58.276-D, 8-15-51.

67. Motion Picture Research Council Bulletin: "New Paints and Sizing Agents for Scenic Backings," 58.724-A, 4-2-54.

68. Motion Picture Research Council Bulletin: "'Arti-Snow,' A New Light Weight Dress Snow," 58.718-A, 12-10-53.

69. Motion Picture Research Council Bulletin: "Improved Falling Snow Effects," 58.423-A, 7-16-52.

70. C. E. Beachell, "Plotting device for the animation stand," *Jour. SMPTE, 63:* 86–87, Sept. 1954.

71. J. Rieck, "Forschungs-Filmaufnahmen in der Dunkelheit auf Infrarotfilm," *Askania-Warte*, No. 43, 1953.

72. J. Rieck and D. Elle, "Ein Tageslicht-Zeitraffer in Verbindung mit der Askania-Z-Kamera," *Askania-Warte*, No. 46, 1954 (*Askania-Warte* is published by: Askania-Werke, 86–89 Bundesallee, Berlin-Friedenau, Germany, U.S. Sector).

73. D. L. MacAdam, "Stereoscopic perception of size, shape, distance and direction," *Jour. SMPTE, 62:* 271–293, Apr. 1954.

74. A. C. Robertson, "Evaluation of the steadiness of 16mm prints," *Jour. SMPTE, 62:* 265–270, Apr. 1954.

75. R. W. Wengel, "Pneumatic pulldown 16mm projector," *Jour. SMPTE, 62:* 384–390, May 1954.

76. Ellis W. D'Arcy and Anton C. Seda, "Application of the xenon arc to the Armed Forces 16mm Projector," *Jour. SMPTE, 63:* 98–104, Sept. 1954.

77. *Jour. SMPTE, 63:* 72, Aug. 1954.

78. William R. Ahern, "Television lighting routines," *Jour. SMPTE, 62:* 189–198, Mar. 1954.

79. F. T. Percy and T. G. Veal, "Lighting contrast for color photographic films in color television," *Jour. SMPTE, 63:* 90–94, Sept. 1954.

80. Richard S. O'Brien, "CBS color-television staging and lighting practices," *Jour. SMPTE, 63:* 41–50, Aug. 1954.

81. William B. Lodge and Howard A. Chinn, "Color-television film shooting practices," *Jour. SMPTE, 63:* 230–232, Dec. 1954; *Am. Cinem., 36:* 142, Mar. 1955.

82. R. G. Neuhaurer, "Vidicon for film pickup," *Jour. SMPTE, 62:* 142–152, Feb. 1954.

83. Henry N. Kozanowski, "Vidicon film reproduction," *Jour. SMPTE, 62:* 153–162, Feb. 1954.

84. A. C. Luther, "Color film equipment," Paper No. 14, presented at 76th SMPTE Convention, Oct. 19, 1954.

85. Edwin C. Fritts, "A 16mm projector for operation with a television film chain on a partial storage basis," Paper No. 12, presented at 76th SMPTE Convention, Oct. 19, 1954.

86. W. F. Fisher and Warren R. Isom, "A 35mm motion-picture projector for color television," presented at 77th SMPTE Convention, Apr. 18–22, 1955.

87. E. H. Traub, "New 35mm television film scanner," *Jour. SMPTE, 62:* 45–54, Jan. 1954.

88. G. R. Tingley, D. J. Pounds and J. H. Haines, "Operational techniques for color film scanners," Paper No. 4B, presented at 76th SMPTE Convention, Oct. 18, 1954.

89. O. Wittel and D. Haefele, "Continuous projector problems," Paper No. 11, presented at 76th SMPTE Convention, Oct. 19, 1954.

90. E. Dudley Goodale, "Recording color television signals," Paper No. 16, presented at 76th SMPTE Convention, Oct. 19, 1954.

91. Lawrence C. Brunswick, "Separation process for additive color motion-picture photography on black-and-white film," *Jour. SMPTE, 64:* 126–128, Mar. 1955.

92. Norman Collins and T. C. Macnamara, "The electronic camera in film making," *Jour. SMPTE, 59:* 445–457, Dec. 1952.

93. National Television System Committee (NTSC), "Color television," *Proc. IRE, 42, No. 1:* Jan. 1954.

94. Joseph G. Reddeck, "Narrow band transmission of NTSC Color Signal," *Proc. IRE, 42, No. 1:* 90–91, Jan. 1954.

95. C. H. Elmendorf, R. D. Ehrbor, R. H. Klie and A. J. Grossman, "The L3 Coaxial System—design," *Bell Sys. Tech. J., 32:* 781–832, July 1953.
R. W. Ketchledge, T. R. Finch, "The L3 Coaxial System—equalization and regulation," *Bell Sys. Tech. J., 32:* 833–878, July 1953.
L. H. Morris, G. H. Lovell, F. R. Dickinson, "The L3 Coaxial System—amplifiers," *Bell Sys. Tech. J., 32:* 879–913, July 1953.
John W. Riecke, R. S. Graham, "The L3 Coaxial System—television terminals," *Bell Sys. Tech. J., 32:* 915–940, July 1953.
H. F. Dodge, B. J. Kinsburg, M. K. Kruger, "The L3 Coaxial System—quality control requirements," *Bell Sys. Tech. J., 32:* 943–967, July 1953.
R. F. Garrett, T. L. Tuffnell, R. A. Waddell, "The L3 Coaxial System—Application of quality control requirements in the manufacture of components," *Bell Sys. Tech. J., 32:* 969–1004, July 1953.

96. H. P. Kelly, "Differential phase and gain measurements in color television systems," *Elec. Engr., 73:* No. 9, 799–802, Sept. 1954.

97. J. Treeby Dickinson, "European television," *Wireless World, 60:* No. 10, 523–524, Oct. 1954.

98. J. Haantjes and T. G. Schut, "Ein Zeilenumsetzer für den internationalen Austausch von Fernseh-programmen," *Philips Technische Rundschau, 16:* No. 1, 1–10, July 1954.

99. D. C. Birkinshaw, "Operating experience with the BBC television studios at Lime Grove," *J. Telev. Soc., 1:* 315, Oct.-Dec. 1954.

100. "Démonstration de télévision en couleur," *Bulletin de l' U.E.R., 5:* No. 28, 752–754; Nov.-Dec. 1954.

101. P. Naslin, Rept. on 2nd Intl. Symposium on High-Speed Photography, *Jour. SMPTE, 63:* 206–208, Nov. 1954.

102. Morton Sultanoff, "Technicalia from the Paris Symposium: a personal review," *Photographic Eng., 5:* No. 4, 290–296, 1954.

103. Harold E. Edgerton, Robert Bonazoli and John T. Lamb, "Duration and peak candlepower of some electronic flashlamps," *Jour. SMPTE, 63:* 15–18, July 1954.

104. W. R. Stamp and R. P. Coghlan, "Growth and decay of light measured photographically from flash-discharge tubes," *Jour. SMPTE, 62:* 105–119, Feb. 1954.

105. Harry L. Parker, "Electronic flashlamps," *Jour. SMPTE, 63:* 105–106, Sept. 1954.

106. C. C. Rockwood and W. P. Harvey, "High-repetition rate stroboscopic light source," *Jour. SMPTE, 63:* 64–66, Aug. 1954.

107. C. C. Rockwood and Richard M. Kuniyuki, "Duo-flash photography," *Jour. SMPTE, 63:* 140–142, Oct. 1954.

108. George E. Merritt, "Use of photography in ballistics measurements," *Jour. SMPTE, 63:* 240–244, Dec. 1954.

109. Morton Sultanoff, "A 0.1 microsecond Kerr-cell shutter," *Photographic Eng., 5:* No. 2, 80–90, 1954 (25 references).

110. R. V. Heine-Geldern, "Kerr cell photography at exposures shorter than one microsecond," abstracted in *Photographic Eng., 5:* No. 2, 138, 1954.

111. Ibid, p. 133.

112. Ibid., p. 134.

113. R. G. Clarke, R. M. Dawson and H. A. Wadman, "A large area source of illumination," *Photographic Eng., 5:* No. 3, 161–165, 1954.

114. Sidney M. Lipton, "Multipurpose optical tracking and recording instrument," *Jour. SMPTE, 62:* 450–459, June 1954.

115. D. D. Lassiter and John Barnett, "Design features of a wide film continuous processor," *Photographic Eng., 5:* No. 3, 166–171, 1954.

116. Herbert E. Hewston and Carlos H. Elmer, "Continuous processing machine for wide film," *Jour. SMPTE, 56:* 613–622, June 1951.

117. Abstracts of several papers at 4th Intl. Symposium on Combustion, *Photographic Eng., 5:* No. 3, 202–203, 1954.

118. John Castle, "The photographic response of several high-speed emulsions at very short exposure times," *Photographic Eng., 5:* No. 3, 189–194, 1954.

119. H. K. Bourne and E. K. Beeson, "The Cineflash," *Jour. SMPTE, 55:* 299–312, Sept. 1950.

Water Flow Rates in Immersion-Washing of Motion-Picture Film

By SAMUEL R. GOLDWASSER

A method is presented for calculating the rate at which water should be supplied for washing motion-picture film in both cascade and parallel types of immersion systems. Formulas are developed which show the relationship between water flow rate and the maximum concentration that can be expected in each tank of a wash system. Other formulas are offered which provide a measure of the rate at which the ultimate concentrations of contaminant are approached. Actual values of water flow rates, concentration of contamination, and contamination time are calculated for several typical wash systems from the formulas derived here. Conclusions arrived at by this theoretical treatment support the practice of washing film in several small tanks, rather than in a single large one.

THE QUANTITY of water needed for washing film depends to a large extent on the manner in which the water is used. How much water one foot of film requires is determined largely by the particular machine in which the operation is performed. One gallon of water per foot of film may barely suffice in one machine, but one-thousandth of a gallon may prove more than enough in another.

Film generally is washed either by immersing it in water or by spraying it with water, but the amount of water required depends only to a minor extent on which of these two methods is used. Neither method can be characterized as inherently more economical or more effective. Refinements in these methods, however, increase their efficiencies tremendously. The refinements discussed in this paper have long been known, and applied, in this industry; this paper merely deals with them in a quantitative, rather than in a qualitative way. Only immersion-wash systems will be treated here, although the same general approach could be used with spray systems.

Hickman[3] pointed out in 1925 that an immersion-wash system with several small tanks requires less water flow than one with a single large tank, and such information has value in film processing when it can be expressed in terms of actual flow rates. The film processor wants to know only how to adjust the valve that controls the water flow, but wants to feel sure that the film is washed adequately, that water is not being wasted, and that unnecessarily large water demands are not preventing him from operating in certain desirable locations.

When complex operations like film-washing are reduced to simple mathematical relationships, much of the uncertainty about these plant processes is eliminated, and the need for control testing is reduced. Chemical engineering literature has shown that leaching operations and extraction operations, which are similar to film washing, can be described with simple formulas. In this paper, general equations are first set up which describe the quantity of contaminant in the wash tanks at any time, and then, by various approximations and mathematical operations, the general equations are reduced to simple expressions. The working formulas that are finally presented can be used to establish flow rates for washing film with minimum waste of water; they will also indicate the concentrations which will result in each of the wash tanks, and will show how rapidly the tanks become contaminated. Ravenscroft[4] has shown that extraction problems can be treated by means of formulas developed from material-balance equations, and that if appropriate parameters are plotted on a graph, the number of tanks needed for a particular set of operating conditions can be quickly determined. Similarly, Ruth[6] has developed a method for solving leaching and extraction problems which yields the results with the accuracy

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SYMBOLS

Symbol	*Definition*	*Units*
C	Concentration of a chemical in wash tank	Grams per liter
C_o	Concentration of a chemical in processing solution preceding the wash	Grams per liter
D	Specific gravity	Grams per milliliter
D_o	Specific gravity of solution carried over into processing solution	Grams per milliliter
f	Quantity of film	Feet
M	Concentration of chemical in next-to-last tank of system with n tanks	Grams per liter
N	Concentration of chemical in last tank of system with n tanks	Grams per liter
n	Total number of tanks in wash system	
P	Rate of carry-over of liquid by film	Milliliters per minute
Q	Rate of flow of wash water	Milliliters per minute
t	Time	Minutes
t'	Time to reach 63% of ultimate concentration	Minutes
T	Tank volume	Milliliters (Note: 1 gallon = 3785 ml)
U	Concentration of chemical in fourth tank of a wash system	Grams per liter
v	Velocity of film in machine	Feet of film per minute
W	Quantity of chemical in wash tank	Grams
X	Concentration of chemical in first tank of a wash system	Grams per liter
Y	Concentration of chemical in second tank of a wash system	Grams per liter
Z	Concentration of chemical in third tank of a wash system	Grams per liter

Subscripts

u	Fourth wash tank
x	First wash tank
y	Second wash tank
z	Third wash tank
1	Condition before film has passed
2	Condition after film has passed
∞	Infinite length of time

permitted by algebraic methods and the speed offered by graphical techniques. Elgin[1] worked out a method in which solute, solvent and inert matter are plotted on a triangular graph; when lines are drawn on the graph, in accordance with concentration changes, the number of wash tanks needed can then be determined. This triangular plot is difficult to apply, however, since parameters must be expressed on a percentage basis relative to each other, and values cannot be read accurately if operating lines are confined to a small portion of the graph.

Some of the methods used for leaching and extraction problems should lend themselves for use in the film-processing industry. Some changes would be needed, however, since they are generally directed, in the chemical industry, at problems involving small, concentrated solutions of a wash solvent containing a valuable product, rather than large volumes of dilute, waste water. Most of the methods presented in chemical engineering literature start with material-balance equations based on steady-state conditions, while the method presented in this paper starts with differential equations that reflect the transient effects and lead to the final working formulas, which are simple to use, listed in Table II. Both methods should, nevertheless, yield essentially the same results, even though the starting points and working formulas differ. The material-balance approach reveals nothing about the rate at which wash solutions become contaminated, while this differential-equation method does provide some measure of the time involved.

The single-tank wash system will first be examined in this paper, and formulas developed for it. Then attention will be directed at a cascade system with two tanks, a cascade system with three tanks, and a cascade system with n tanks. Finally, formulas will be developed for a parallel wash system with two tanks, a parallel system with three tanks, and a parallel system with n tanks. Examples are presented with each type to show how the formulas can be applied. In cascade systems, fresh water is supplied only to the last tank, and flows countercurrent to the film; in parallel systems, fresh water is supplied to each tank independently. Symbols used in the various equations and formulas are defined in the tabulation, while the arrangement of tanks in the different systems is illustrated in the diagrams of Fig. 1. It will be noted that the numbering starts with the tank where the film first enters the wash system.

Single Wash Tank

Solution is carried into the one-tank wash system by film at the rate of P milliliters per minute, as shown in Fig. 1, while wash water is supplied at the rate of Q ml/min. The rate at which the wash tank becomes contaminated can be expressed by the following differential equation[5]:

$$\frac{dW}{dt} = PC_0 - \frac{W(Q + P)}{T} \qquad (1)$$

This equation can be readily integrated, then solved either for concentration or for time:

$$\frac{X}{C_0} = \frac{1}{Q/P + 1}\left[1 - e^{\frac{-Pt}{T}(Q/P+1)}\right] \qquad (2)$$

$$t = \frac{-T}{P(Q/P + 1)} \ln\left[1 - \frac{X}{C_0}(Q/P + 1)\right] \qquad (3)$$

Both of these equations lead to significant information. After an infinite length of time has passed, the exponential term of Eq. 2 drops out, and the concentration of contaminant in the tank reaches its maximum value. Equation 2 then resolves to the following simple form:

$$\frac{X_\infty}{C_0} = \frac{1}{Q/P + 1} \qquad (4)$$

In practice, a value for the greatest permissible contamination is first estimated, and the Q/P ratio required to confine the concentration below this level is then calculated from Eq. 4. An indication of the rate at which this maximum concentration is approached can be gotten from Eq. 3. At some particular time t', Eq. 3 will reduce to:

$$t' = \frac{T}{P(Q/P + 1)} = \frac{T}{P}\,\frac{X_\infty}{C_0} \qquad (5)$$

This simple time relationship exists only when the logarithmic portion of Eq. 3 has a value of -1, and this occurs when the ratio X/X_∞ is equal to $(e-1)/e$. Since this latter term has a value of 0.633, it can then be said that Eq. 5 indicates the time that must elapse before the tank solution reaches 63.3% of its maximum concentration. Practical formulas for the single-tank wash system are thus described by Eqs. 4 and 5; similar ones will be developed for the other types of wash systems.

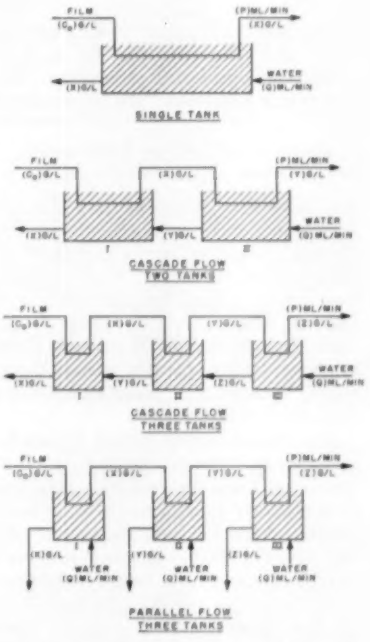

Fig. 1. Arrangement of tanks of cascade and parallel wash systems

Example 1

An actual single-tank installation will now be considered, and values for flow rate and equilibrium time will be calculated. Multiple-tank wash systems will subsequently be treated in a similar way, and the results compared. In all the examples presented here, carryover rate is assumed to be 200 ml/min,* and the maximum concentration permitted in the final wash tank is taken as 0.1% of C_0. Also, it is assumed that all tanks are initially filled with clean water; that the volume of liquid in a tank does not change; and that the total volume of the wash system is 100 gal. For the single-tank system, substitution of the above values in Eq. 4 yields:

$$X_\infty/C_0 = 10^{-3} = (Q/P + 1)^{-1}$$
$$Q/P = 999$$
$$Q = 999\,(200) = 199{,}800 \text{ ml/min}$$

From Eq. 5, a time value is obtained:

$$t' = \frac{T}{P}\,(X_\infty/C_0) = \frac{100(3785)}{200}\,(10^{-3}) = 1.9 \text{ min.}$$

Note that the 3785 figure represents a conversion unit to change from gallons to liters. Evidently over 50 gal of water must be supplied every minute to this system; also, this system becomes contaminated very rapidly. Some additional washing can be gained by allowing the fresh supply water to be sprayed over the film at the exit end, rather than by running the water directly into the wash tank.

Two Tanks, Cascaded

Formulas for a wash system with two tanks, where the wash liquid cascades in a direction opposite to that of the film, will now be derived. Such an immersion system is shown diagrammatically in Fig. 1. In tank II, the change in concentration of contaminant is described by the equation:

$$\frac{dW_y}{dt} = PX - \frac{W_y}{T}(P + Q) \qquad (6)$$

* This figure is based on a carryover rate of 2¼ ml/ft of 35mm film in a machine operating at 90 ft/min and was obtained by use of Eq. 49.

Table I. Working Formulas for 1, 2, 3 and 4 Cascaded Tanks.

No. of tanks in wash system	Relative concentration: g/l/g/l In tank I X_∞/C_0	In tank II Y_∞/C_0	In tank III Z_∞/C_0	In tank IV U_∞/C_0
One	$\frac{Q/P-1}{(Q/P)^2-1}$	—	—	—
Two	$\frac{(Q/P)^2-1}{(Q/P)^3-1}$	$\frac{Q/P-1}{(Q/P)^3-1}$	—	—
Three	$\frac{(Q/P)^3-1}{(Q/P)^4-1}$	$\frac{(Q/P)^3-1}{(Q/P)^4-1}$	$\frac{Q/P-1}{(Q/P)^4-1}$	—
Four	$\frac{(Q/P)^4-1}{(Q/P)^5-1}$	$\frac{(Q/P)^3-1}{(Q/P)^5-1}$	$\frac{(Q/P)^2-1}{(Q/P)^5-1}$	$\frac{Q/P-1}{(Q/P)^5-1}$

With the passage of time, the differential term plays an increasingly minor role, until at equilibrium it drops out completely. We may, therefore, if the tanks are of equal volume, write

$$\frac{W_y}{W_x} = \frac{Y}{X} = \frac{P}{P+Q} = \frac{1}{Q/P+1} \quad (7)$$

In tank I the conditions may also be described by a differential equation:

$$\frac{dW_x}{dt} = PC_0 + QY - \frac{W_x}{T}(Q+P) \quad (8)$$

Substituting in this equation the approximate value of Y obtained above gives:

$$\frac{dW_x}{dt} = PC_0 + \frac{QPW_x}{T(Q+P)} - \frac{W_x(Q+P)}{T} \quad (9)$$

Integration will lead to the following results:

$$t = \left(\frac{-T}{P}\right)\frac{Q/P+1}{(Q/P)^2+Q/P+1} \ln\left[1-\left(\frac{X}{C_0}\right)\frac{(Q/P)^2+Q/P+1}{Q/P+1}\right] \quad (10)$$

$$\frac{X}{C_0} = \frac{Q/P+1}{(Q/P)^2+Q/P+1}\left[1-e^{\frac{-Pt}{T}\frac{(Q/P)^2+Q/P+1}{Q/P+1}}\right] \quad (11)$$

After an infinite length of time, the concentration in tank I becomes:

$$\frac{X_\infty}{C_0} = \frac{Q/P+1}{(Q/P)^2+Q/P+1} \quad (12)$$

while in tank II the concentration will be:

$$\frac{Y_\infty}{C_0} = \frac{1}{(Q/P)^2+Q/P+1} \quad (13)$$

The time it takes for the tanks to reach 63% of the final equilibrium concentration is:

$$t' = \left(\frac{T}{P}\right)\frac{Q/P+1}{(Q/P)^2+Q/P+1} = \frac{T}{P}\frac{X_\infty}{C_0} \quad (14)$$

One additional simplification can be introduced. The term $[(Q/P)^2 + Q/P + 1]$ forms a geometric progression. The sum of such a series can also be expressed as:

$$\frac{(Q/P)^3-1}{Q/P-1}$$

Equations with a large number of terms in a series, such as those subsequently derived, are solved more easily when expressed this way. The final working formulas for cascade systems with 1, 2, 3 and 4 tanks therefore contain the equivalent expressions for the sum of the series, rather than the progressions themselves. These working formulas are listed in Tables I and II.

The validity of Eqs. 12 and 13 may be questioned, however, because in their derivation Y was replaced by a term that is not always equivalent to it. A more rigorous proof will yield the same working formulas. This exact proof is offered here for the two-tank system; confirmation of results is considered to prove that the less rigorous type of proof will serve for all multiple-tank cascaded systems. In tank I,

$$\frac{dW_x}{dt} = PC_0 + QY - \frac{W_x(Q+P)}{T} \quad (15)$$

which may be written[5] as:

$$\left(D + \frac{Q+P}{T}\right)W_x - \frac{Q}{T}W_y = PC_0 \quad (16)$$

In tank II,

$$\frac{dW_y}{dt} = PX - \frac{W_y(Q+P)}{T} \quad (17)$$

which may, similarly, be written as:

$$\frac{P}{T}W_x - \left(D + \frac{Q+P}{T}\right)W_y = 0 \quad (18)$$

and then as:

$$\left(D + \frac{Q+P}{T}\right)W_x - \frac{T}{P}\left(D + \frac{Q+P}{T}\right)^2 W_y = 0 \quad (19)$$

After subtraction and rearrangement of terms of Eqs. 16 and 19, the following expression is obtained:

$$\left[D^2 + \frac{2(Q+P)}{T}D + \frac{Q^2+QP+P^2}{T^2}\right]W_y = \frac{P^2}{T}C_0 \quad (20)$$

This equation may be solved for W_y, and the following formula for concentration of contaminant in tank II then results:

$$Y = K_3\left[1 - \frac{K_1}{2\sqrt{Q/P}}e^{\frac{-PK_3t}{T}} + \frac{K_2}{2\sqrt{Q/P}}e^{\frac{-PK_3t}{T}}\right] \quad (21)$$

Similarly, the formula for concentration of contaminant in tank I is:

$$X = K_3\left[Q/P + 1 - \frac{K_1}{2}e^{\frac{-PK_3t}{T}} - \frac{K_2}{2}e^{\frac{-PK_3t}{T}}\right] \quad (22)$$

The constants have the following values:

$$K_1 = Q/P + \sqrt{Q/P} + 1 \quad (23)$$

$$K_2 = Q/P - \sqrt{Q/P} + 1 \quad (24)$$

$$K_3 = \frac{C_0}{(Q/P)^2+Q/P+1} \quad (25)$$

At this point it becomes clear that the rigorous proof will also lead to the working formulas for X_∞ and Y_∞ which have been derived.

Example 2

The working formulas will now be applied to a wash system consisting of two 50-gal tanks. The formulas used in these calculations are obtained directly from Table I, while the various constants have the same values as in Example 1.

$$Y_\infty/C_0 = 10^{-3} = \frac{Q/P-1}{(Q/P)^2-1}$$

$$Q/P = 31.2 \quad Q = 31.2\,(200) = 6240 \text{ ml/min}$$

$$X_\infty/C_0 = \frac{X}{Y}(Y_\infty/C_0) = (Q/P+1)(10^{-3}) = 32.2\,(10^{-3}) = 3.22\%$$

Table II. Working Formulas for Cascaded and Parallel Systems Consisting of n Tanks.

Type of system	Relative concentration: g/l/g/l In tank I X_∞/C_0	In tank II Y_∞/C_0	...	In next-to-last tank M_∞/C_0	In last tank N_∞/C_0	Time t' minutes
Cascade	$\frac{(Q/P)^n-1}{(Q/P)^{n+1}-1}$	$\frac{(Q/P)^{n-1}-1}{(Q/P)^{n+1}-1}$	...	$\frac{(Q/P)^2-1}{(Q/P)^{n+1}-1}$	$\frac{Q/P-1}{(Q/P)^{n+1}-1}$	$\frac{TX_\infty}{PC_0}$
Parallel	$\frac{1}{Q/P+1}$	$\frac{1}{(Q/P+1)^2}$	...	$\frac{1}{(Q/P+1)^{n-1}}$	$\frac{1}{(Q/P+1)^n}$	$\frac{T}{P}\frac{1}{Q/P+1}$

shown in Fig. 1, and formulas will now

$$t' = \frac{T}{P}(X_\infty/C_0) = \frac{50\,(3785)}{200}(0.0322)$$
$$= 30.4 \text{ min.}$$

A partition in a 100-gal tank evidently reduces the water demand by 97%, and diminishes the rate at which equilibrium is approached by a factor of 16. If a flow rate twice the calculated value were used (i.e., 12,480 ml/min), equilibrium would be approached almost twice as rapidly. Results calculated in all of the examples are listed in Table III.

Table III. Summary of Results Calculated in Examples.

No. of wash tanks	Total water flow (Q)ml/min		Time (t')minutes		Concentration in first tank, ($X\infty/C_0$)	
	Cascade system	Parallel system	Cascade system	Parallel system	Cascade system	Parallel system
1	199,800	199,800	1.9	1.9	0.1%	0.1%
2	6,240	12,200	30.4	30	3.22	3.17
3	1,930	5,400	65.5	63	10.4	10.0
4	1,069	3,700	88.5	84	18.7	17.8
10	369	1,990	102	95	54.2	50.1

Three Tanks Cascaded

In an immersion system consisting of three cascaded tanks, as shown in Fig. 1, the material balance around tank III is:

$$YP = Z(Q + P) \tag{26}$$

so that

$$Z/Y = \frac{1}{Q/P + 1} \tag{27}$$

Similarly, at tank II,

$$XP + ZQ = Y(Q + P) \tag{28}$$

so that

$$Y/X = \frac{Q/P + 1}{(Q/P)^2 + Q/P + 1} \tag{29}$$

Finally, at tank I the exact differential equation can be set up:

$$\frac{dW_x}{dt} = PC_0 + YQ - \frac{W_x(Q + P)}{T} \tag{30}$$

The approximate value for Y obtained in Eq. 29 may be substituted in Eq. 30, giving:

$$\frac{dW_x}{dt} = PC_0 + \frac{W_xQP(Q + P)}{T(Q^2 + QP + P^2)} - \frac{W_x(Q + P)}{T} \tag{31}$$

Integration will lead to the following results:

$$t = \frac{-T((Q/P)^3 + Q/P + 1)}{P[(Q/P)^2 + (Q/P)^2 + Q/P + 1)]} \ln\left[1 - \frac{X}{C_0}\,\frac{(Q/P)^3 + (Q/P)^2 + Q/P + 1}{(Q/P)^2 + Q/P + 1}\right] \tag{32}$$

$$\frac{X}{C_0} = \frac{(Q/P)^3 + Q/P + 1}{(Q/P)^3 + (Q/P)^2 + Q/P + 1}\left[1 - e^{\left(\frac{-Pt}{T}\right)\frac{(Q/P)^3 + (Q/P)^2 + Q/P + 1}{(Q/P)^2 + Q/P + 1}}\right] \tag{33}$$

Formulas for concentrations in each of the three tanks after infinite time, and for the time at which 63% of the ultimate concentrations are reached, can be easily deduced from these equations by methods described previously, and they are listed in Table I.

Example 3

The following computations show how these working formulas can be applied to a wash system consisting of three 33½-gal tanks arranged in cascade:

$$Z_\infty/C_0 = 10^{-3} = \frac{Q/P - 1}{(Q/P)^3 - 1}$$

$$Q/P = 9.65 \quad Q = 9.65\,(200) = 1930 \text{ ml/min}$$

$$Y_\infty/C_0 = (Q/P + 1)(Z_\infty/C_0) = 10.65\,(10^{-3}) = 1.065\%$$

$$X_\infty/C_0 = \frac{(Q/P)^3 - 1}{Q/P - 1}(Z_\infty/C_0) = \frac{9.65^3 - 1}{8.65}(10^{-3}) = 10.4\%$$

$$t' = \frac{T}{P}(X_\infty/C_0) = \frac{33^1/_3(3785)}{200}(0.104) = 65.5 \text{ min}$$

Cascade System, Generalized

Formulas for systems with any number of cascaded tanks can be deduced from the formulas for systems with one, two and three tanks, provided that equilibrium is attained between the film and each of the tank solutions. Ultimate concentration of chemical in the last tank of the general system is described by the following expression:

$$N_\infty/C_0 = [(Q/P)^n + (Q/P)^{n-1} + (Q/P)^{n-2} + \ldots 1]^{-1} \tag{34}$$

When treated as a geometric progression this equation will reduce to the following simpler form:

$$N_\infty/C_0 = \frac{(Q/P) - 1}{(Q/P)^{n+1} - 1} \tag{35}$$

Similar treatment will yield formulas for concentrations in the other tanks of the general system. In Table II, the concentrations in a system consisting of n tanks are listed. These equations apply only if enough washing time is allowed. They are based on dilution effects, neglecting delays due to diffusion, even though diffusion effects are not always negligible.

As the number of tanks in a wash system is increased, less contaminant reaches the final tank, providing diffusion time is very short. This holds true regardless of the size of the tanks, for size affects only rate of contamination and not ultimate extent. A large number of small tanks will therefore serve far more effectively than a small number of large tanks. If it were possible to have a wash system with an infinite number of tanks, only a slight trickle of wash water is needed. This is revealed by Eq. 35 which shows that in a system with an infinite number of tanks, perfect washing is accomplished as long as the wash water flows at a rate slightly larger than the carryover rate. Also, the spent wash liquid in such a system becomes as concentrated as the processing solution itself, and, neglecting solubility properties, such a system utilizes the water furnished to it to the fullest extent. If a 100% efficient wash system is considered as one with a Q/P value of 1, efficiencies of other systems can therefore be described by the inverse of their Q/P ratios.

An infinite number of cascaded wash tanks cannot be incorporated in a processing machine, but virtually the same effect can be achieved by means of a long narrow tube, in which the film and the water travel in opposite directions. Of all practical wash systems, therefore, the tubular type requires the least water. If contaminants in film could achieve equilibrium with the solution immediately, leaching out into the wash liquid without delay, a short tube would suffice. However, it does take considerable time[3] for chemicals to diffuse through the gelatin and mix adequately with the wash liquid, particularly where the concentration difference is not appreciable, so that the length of the tube is determined largely by diffusion effects. Further remarks about diffusion rate fall outside the scope of this paper, however. As for the cross-sectional area of the tube, it need not be large, for it affects only the time required to attain final equilibrium conditions. A system with a wide tube will wash the film cleaner than a narrow tube only at the beginning; after they have been in use for a long time, they both would act equally well.

Example 4

The working formulas for cascade systems with n tanks will now be applied. First a system with four 25-gal tanks, and then a system with ten 10-gal tanks, will be examined.

Four Tanks

$$U_\infty/C_0 = 10^{-2} = \frac{Q/P - 1}{(Q/P)^5 - 1}$$

$$Q/P = 5.34 \quad Q = 5.34\,(200) = 1069 \text{ ml/min}$$

$$Z_\infty/C_0 = (Q/P + 1)(U_\infty/C_0) = 6.34(10^{-2}) = 0.634\%$$

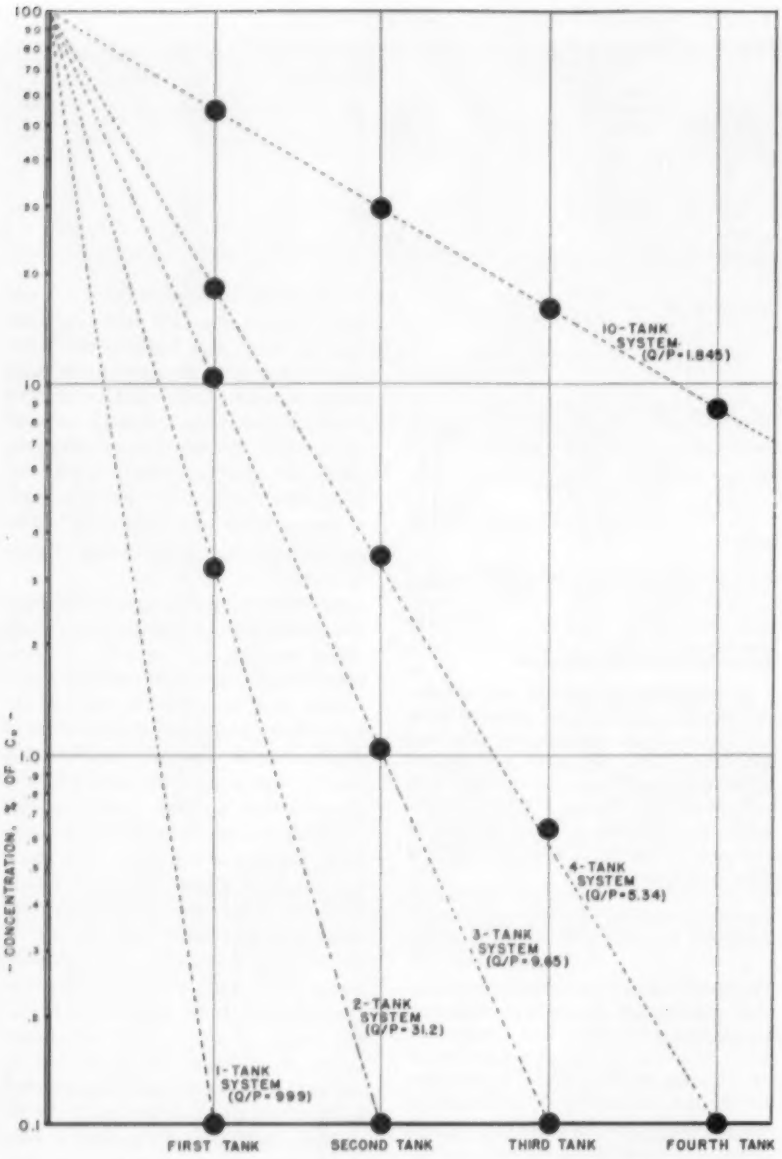

Fig. 2. Concentrations calculated in Examples 1, 2, 3 and 4.

$$Y_\infty/C_0 = \frac{(Q/P)^3 - 1}{Q/P - 1}(U_\infty/C_0) = \frac{5.34^3 - 1}{4.34}(10^{-3}) = 3.48\%$$

$$X_\infty/C_0 = \frac{(Q/P)^4 - 1}{Q/P - 1}(U_\infty/C_0) = \frac{5.34^4 - 1}{4.34}(10^{-3}) = 18.7\%$$

$$t' = \frac{T}{P}(X_\infty/C_0) = \frac{25(3785)}{200}(0.187) = 88.5 \text{ min}$$

Ten Tanks

$$N_\infty/C_0 = 10^{-3} = \frac{Q/P - 1}{(Q/P)^{11} - 1}$$

$Q/P = 1.845$ $Q = 1.845(200) = 369$ ml/min

$$t' = \frac{10(3785)}{200}\frac{(Q/P)^{10} - 1}{(Q/P)^{11} - 1} = \frac{10(3785)}{200}\frac{1}{Q/P} = \frac{37850}{200}\frac{1}{1.845} = 102 \text{ min}$$

Concentration calculated in Examples 1, 2, 3 and 4 are plotted in Fig. 2. When lines are drawn joining concentration values in each of the cascade systems, the lines evidently converge. Also, concentrations in a cascade system are evidently equally spaced.

Parallel Tanks

Each tank in a parallel wash system is supplied directly with clean water, as shown in Fig. 1, and formulas will now be derived. It is assumed that the tanks are supplied with water at equal rates of flow. In tank I, the following equation applies:

$$\frac{dW_x}{dt} = PC_0 - \frac{W_x(Q + P)}{T} \quad (36)$$

This will solve to:

$$t = \frac{-T}{Q + P}\ln\left[1 - \frac{X}{C_0}(Q/P + 1)\right] \quad (37)$$

$$\frac{X}{C_0} = \frac{1}{Q/P + 1}\left[1 - e^{\frac{-Pt}{T}(Q/P+1)}\right] \quad (38)$$

Similarly, in tank II,

$$\frac{dW_y}{dt} = PX - \frac{W_y(Q + P)}{T} \quad (39)$$

Substituting for X in this equation gives:

$$\frac{dW_y}{dt} = \frac{P^2C_0}{Q + P} - \frac{W_y(Q + P)}{T} \quad (40)$$

When integrated, this will yield:

$$t = \frac{-T}{Q + P}\ln\left[1 - \frac{Y}{C_0}(Q/P + 1)^2\right] \quad (41)$$

$$\frac{Y}{C_0} = \frac{1}{(Q/P + 1)^2}\left[1 - e^{\frac{-Pt}{T}(Q/P+1)}\right] \quad (42)$$

Finally, in tank III,

$$\frac{dW_z}{dt} = PY - \frac{W_z(Q + P)}{T} = \frac{P^3C_0}{(Q + P)^2} - \frac{W_z(Q + P)}{T} \quad (43)$$

which yields, on integration,

$$t = \frac{-T}{Q + P}\ln\left[1 - \frac{Z}{C_0}(Q/P + 1)^3\right] \quad (44)$$

$$\frac{Z}{C_0} = \frac{1}{(Q/P + 1)^3}\left[1 - e^{\frac{-Pt}{T}(Q/P+1)}\right] \quad (45)$$

A set of working formulas can readily be extrapolated from these equations. Concentration after infinite time can obviously be expressed as follows:

$$X_\infty/C_0 = \frac{1}{Q/P + 1} \quad (46)$$

$$Y_\infty/C_0 = \frac{1}{(Q/P + 1)^2} \quad (47)$$

$$Z_\infty/C_0 = \frac{1}{(Q/P + 1)^3} \quad (48)$$

Also, the time required to reach 63% of the final concentration values is evidently equal to $\frac{T}{P}\left(\frac{1}{Q/P + 1}\right)$. The general formulas for wash systems with any number of parallel tanks can readily be deduced from these equations, and they are listed in Table II.

Example 5

The formulas for parallel-tank wash systems will now be applied. Just as in the cascaded systems, total capacity is chosen as 100 gal; contaminant should not exceed 0.1% of C_0 in value; and the carryover rate amounts to 200 ml/min. It is desired to determine flow rates and time values for systems with 2, 3, 4 and 10 chambers:

2 Tanks

$$Y_\infty/C_0 = 10^{-3} = (Q/P+1)^{-2}$$

$$Q/P = 30.5 \quad Q = 30.5(200) = 6100 \text{ ml/min}$$

$$Q_{total} = 2(6100) = 12{,}200 \text{ ml/min}$$

$$t' = \frac{T}{P}\frac{1}{(Q/P+1)} = \frac{50(3785)}{200}\frac{1}{31.5} = 30 \text{ min.}$$

3 Tanks

$$Z_\infty/C_0 = 10^{-3} = (Q/P+1)^{-3}$$

$$Q/P = 9 \quad Q = 9(200) = 1800 \text{ ml/min}$$

$$Q_{total} = 3(1800) = 5400 \text{ ml/min}$$

$$t' = \frac{T}{P}\frac{1}{Q/P+1} = \frac{33(3785)}{200}\frac{1}{10} = 63 \text{ min.}$$

4 Tanks

$$U_\infty/C_0 = 10^{-3} = (Q/P+1)^{-4}$$

$$Q/P = 4.62 \quad Q = 4.62(200) = 925 \text{ ml/min}$$

$$Q_{total} = 4(925) = 3700 \text{ ml/min}$$

$$t' = \frac{T}{P}\frac{1}{Q/P+1} = \frac{25(3785)}{200}\frac{1}{5.62} = 84.4 \text{ min.}$$

10 Tanks

$$N_\infty/C_0 = 10^{-3} = (Q/P+1)^{-10}$$

$$Q/P = 0.995 \quad Q = 0.995(200) = 199 \text{ ml/min}$$

$$Q_{total} = 199(10) = 1990 \text{ ml/min}$$

$$t' = \frac{10(3785)}{200}\frac{1}{1.995} = 95 \text{ min.}$$

Measurements

Certain parameters should be measured in order to establish flow rates and to check the effectiveness of the washing process. One simple method of determining carryover rates[3] requires only that specific gravity be measured. The specific gravity of a solution subjected to dilution by carryover is measured before, and after, a known quantity of film passes, and the values are then substituted in the following formula:

$$P = T\frac{v}{f}\ln\left[\frac{D_1 - D_0}{D_2 - D_0}\right] \qquad (49)$$

where D_1 and D_2 refer to specific gravity of the processing solution; D_0 refers to the specific gravity of the solution (generally water) which is carried in; v indicates machine speed in feet of film per minute; and f shows footage of film processed. To measure flow rates, a flow meter may be inserted in the line; or overflow may be collected for a measured period of time; or a weir may be cut in one of the tanks. To determine the extent of contamination of a wash solution, analytical methods or specific gravity measurements may be used. Only traces of contaminant ordinarily occur in the last of a series of tanks, so that sensitive analytical methods would be required. Measurements may be made, instead, on the solutions in tanks I or II, where the gross effects occur, and then the degree of contamination of the last tank can be calculated from relationships implicit in Table II. To determine the amount of sodium thiosulfate present in the final wash tank or stabilizer solution, the following procedure is offered:

To a 10-ml colorimeter tube there is added 5.0 ml of the sample, $2\frac{1}{2}$ ml of starch solution, and $2\frac{1}{2}$ ml of 1:1 hydrochloric acid. After the solution is mixed, the tube is placed in the Klett colorimeter and, with the green filter in place, the instrument is set for a zero reading. Then 1.0 ml of a 0.002N solution of iodine is added, mixed, and the instrument read. This process is repeated using 5.0 ml of water instead of the sample. The difference in readings will provide a measure of the amount of thiosulfate present. Calibration curves can be established from standards containing 0 to .0004 *eq*/l of thiosulfate.

Conclusion

Mathematical relationships between water flow rates, carryover rates, and the contamination of the wash solutions in immersion systems have been presented in this paper. From these formulas it is possible to compute the flow of water needed in single-tank and multiple-tank wash systems for the same degree of washing. Comparison of the cascade-flow system with the parallel-flow system shows that the former uses the wash system more efficiently. Finally, the long narrow tube is shown to be a special type of cascade system, using wash water at virtually the highest possible degree of efficiency.

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References

1. J. C. Elgin, "Graphical calculations of leaching operations," *Trans. Am. Inst. Chem. Engrs., 32:* 451–471 (1936).
2. S. R. Goldwasser, "Mathematical approach to replenishment techniques," *Jour. SMPTE, 62:* 11–23, Jan. 1954.
3. K. C. D. Hickman, "Washing motion picture film," *Trans. SMPE,* No. 23, 62, Oct. 1925.
4. E. A. Ravenscroft, "Extraction of solids with liquids," *Ind. Eng. Chem., 28:* No. 7, 851–855 (1936).
5. H. W. Reddick and F. H. Miller, *Advanced Mathematics for Engineers,* John Wiley and Sons, New York, 2d ed., 1947, pp. 1–36.
6. B. F. Ruth, "Semigraphical methods of solving leaching and extraction problems," *Chem. Eng. Progress, 44:* No. 1, 71–80 (1948).

Evaluation and Reaction: New Processes of Motion-Picture Presentation

By LUCIEN E. POPE and RICHARD H. OREAR

A retrospective review of the problems involved in the conversion of many theaters for the various methods of motion-picture presentation is made. Patron acceptance influences management justification for required modifications for these newer processes. The authors have faced problems of equipping over 200 theaters for the changed presentation processes.

THE PROPER presentation of new screen processes is of paramount importance to all theaters. It is often difficult, and many times virtually impossible, to convert motion-picture theaters so that this proper presentation can be made.

The problems connected with this conversion began with the first presentation of Cinerama. This new process required theaters having extreme width in order to accommodate the screen. Cinerama presentation required a screen at least 51 ft wide and 25 ft high. Cinerama also required the use of three projection booths, each projecting from a different angle. The combined use of a 146° horizontal viewing angle, 55° high, and six soundtracks created a sense of audience participation never before realized.

The public was quick to accept this new medium, but the number of theaters and cities that could support the high conversion cost and operating cost was limited, therefore the widespread use of this medium did not develop.

Public acceptance of Cinerama forced all branches of the motion-picture industry to search for new ideas and new processes — processes that could apply to all the 15,000 hard-top theaters and 4000 drive-in theaters. The technicians collaborated with producers and exhibitors, and stereoscopic pictures were reborn. The novelty of *Bwana Devil* captured the fancy of many theater patrons. This inspired Warner Bros. to make *House of Wax*, with the first attempt at stereophonic sound. So successful was this picture that management rushed to convert theaters to 3-D, many with stereophonic sound reproduced from separate magnetic sound reproducers. The problems of converting theaters for this process were many and costly. All screens had to have a metallic surface. This required refinishing or new screens, if available. Refinishing also brought its headaches; inherent with metallic reflective surfaces, seams suddenly appeared and blemishes appeared in the finish coat. Polarized filters for the projectors were often poorly made and had a high mortality rate.

In order to create the proper stereoscopic effect, both projectors had to operate in perfect synchronism. This was no simple matter and many homemade devices were tried with disastrous results. Film was shipped on 4000-ft reels and this required new magazines, new free-wheeling reels, complete redesigning of take-up mechanisms and film spill-off shafts. Special free-wheeling reels were designed to cut down on the film drag to prevent damage.

Because nearly 40% of the light available to the patron's eyes was lost in the projector filters and the polarized glasses worn by the patron, the light source had to be increased. In many theaters new larger arc lamps had to be secured, and in many theaters, because both lamps must operate simultaneously, an additional generator or rectifier had to be added. This extra power load required new service and often resulted in almost complete rewiring of the theater.

Management was forced to make a difficult decision, but in the majority of cases where 3-D was presented properly to a new audience, public acceptance was gratifying. In nearly every theater in our operation, the records show that public rejection of 3-D was caused by poor presentation or improper equipment.

Installation of CinemaScope

The development of the CinemaScope process of presentation required extensive engineering of each theater. Most of the theaters that the authors have equipped were designed around a screen proportion of 1.33 to 1. In simple language this means that the sight lines, projection light beams and proscenium openings were designed for that ratio. CinemaScope requires the use of an aspect ratio of 2.55 to 1 for presentation of film with magnetic sound striping, and 2.35 to 1 for optically reproduced sound. This change in aspect ratios caused many problems relating to viewing angles and projection light beams.

As stated before, engineering studies were made of each theater to be converted; from these studies the required extent of conversion was determined. In general it was agreed that proper presentation of CinemaScope depended upon creating the illusion of audience participation. To accomplish the sense of participation, the screen had to be of maximum width and still be in good proportion with the rest of the theater. As an example, the majority of theaters in small- and medium-sized cities, even many suburban theaters near the larger cities, are built on lots only 50 ft wide. This results in a proscenium opening of approximately 30 ft. The remaining space is used for exits, etc. The CinemaScope picture in this type of theater is only 12 ft 6 in. high, which is most unsatisfactory, since it appears actually smaller than the average picture previously presented in such theaters, 15 ft × 20 ft. The exhibitor in this type of theater was forced to make extensive structural alterations, costing thousands of dollars. If his theater happened to have a low overhanging balcony, sight lines were limited and the structural problems required to correct this condition were nearly insurmountable. To overcome these problems, many screens were placed in front of the proscenium arch. This resulted in the proper-size picture for the theater, but it also resulted in a loss of many seats, usually eight to ten rows. When the screen was placed in front of the proscenium, it was difficult to provide adjustable masking and close-in curtains. This destroyed the showmanship necessary for popular boxoffice appeal. Adjustable maskings are essential because not all pictures are produced in CinemaScope ratios.

The problems of CinemaScope presentation are not confined to the screen and the stage; the projection booth also presents certain problems. The increased size of the picture requires more light and the resultant use of higher amperage. Higher amperage increases heat on the film. The projection-machine manufacturers are working on this problem, but to date have not developed a foolproof system of heat dissipation. Many devices have been tried, with varying degrees of success. The principal problem caused by this heat is the expansion of the film, which causes the film to buckle and go in and out of focus. The extra heat also causes expansion of the projector and some movement of the lens, resulting in bad focus.

Concurrent with the conversion of theaters to CinemaScope, the exhibitor

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usually installed extra lens and aperture plates so that he might present pictures in wide-screen ratios. Usually this was accomplished with 1.66-to-1, or, in some extreme cases, 1.75-to-1 ratios. Wide screen created a demand for short focal length lenses. These lenses were generally in the order of 2.25 to 3.00 in. E.F.L. The optical manufacturers have made every effort to improve their lenses in these focal lengths, but much work still needs to be done. The focal point in these ranges is so critical that the operator must refocus after each reel and be continuously alert. The extra heat, previously mentioned, causes movement of the lens carrier and results in an out-of-focus condition. The definition of lenses of this focal range is also very bad. In an attempt to improve the definition and critical focal point, the authors have ordered $f/1.7$ and $f/1.8$ lens stopped down to $f/2.0$ and $f/2.2$. The stopping of the lens has resulted in greatly improved definition, and, owing to the high quality of the $f/1.7$ and $f/1.8$ lenses, has resulted in a much better picture. Stopping the lens has resulted in a slight loss of light, but this is not nearly so objectionable as the lack of picture definition.

The CinemaScope process requires the squeezing of the picture in width and a compression ratio of 2 to 1. The expansion of this squeeze for projection is accomplished with an anamorphic device. Several anamorphic devices are available for this purpose, each undoubtedly serving its own purpose very well. It must be remembered that picture quality of CinemaScope presentation can be no better than the objective lens used with the anamorphic attachment. All CinemaScope pictures that have been released to date are compressed in the ratio of 2 to 1, and the use of variable anamorphic devices to expand or contract beyond these ratios can only result in distortion, thus poor presentation.

SuperScope

SuperScope is another process of presentation of compressed prints. This process also used the compression ratio of 2 to 1, making it possible to use the anamorphic device used for CinemaScope. A new aperture plate is required because the centerline of the picture frame has been shifted slightly to accommodate the optical soundtrack.

VistaVision

VistaVision is a process created by one of the major studios for the improvement of definition on the screen. This process consists of photographing the scene by means of a large negative. The standard 35mm negative is filmed through a special camera which exposes the size of two frames in a horizontal direction. The positive, thus exposed, is reduced when printed and is reversed to produce a standard 35mm print. The size in printing is kept to 1.85-to-1 aspect ratio. The proponents of this method claim increased definition and less graininess on enlarged images. In a few installations, film has been projected in a horizontal direction, the release print being double-sized frames instead of standard-sized. This allows increased aperture sizes and a great increase of light. The cost of special projectors for this purpose does not warrant conversion in all theaters at this time.

Simultaneously with the presentation of CinemaScope, magnetically reproduced sound was introduced. Stereophonic sound, as presented with CinemaScope, consisted of four separate magnetic stripings applied to the film. The reproduction of this sound was accomplished by adding the penthouse type of soundheads to the projectors. The sound is picked up from the soundheads, and the output of each track is amplified through a separate amplifier and horn system. The purpose of stereophonic sound is to create the illusion of audience participation by causing the sound to follow the action on the screen — that is, to move back and forth as the characters across the screen. Stereophonic sound is also created from optical soundtracks by means of an integrator; this process, called Perspecta sound, requires three amplifiers and horn systems. If the exhibitor wants to have stereophonic sound with either optical or magnetic tracks, he must buy what amounts to three or, if surround speakers are used, four complete sound systems. More effective use of surround speakers must be made if full value is to be received from the fourth soundtrack. In general, more information or signal is desired.

The disappointing boxoffice figures on most 3-D grosses caused management to scrutinize all expenditures very carefully. Because of this, the CinemaScope process was held back in many small theaters. When boxoffice receipts from CinemaScope continued to climb, management became more eager to remodel and revamp theaters to present CinemaScope properly. We find that surveys are again required to ascertain the requirements of some theaters already presenting CinemaScope. In other words, some early installations were made during a rush period when many types of equipment were not available and little showmanship was used.

The refinement or deluxe period has now been reached, and the next year or two will see many theaters redesigned around the larger CinemaScope screen, with draperies, close-in curtains and adjustable masking. This will, in some cases, require the removal of the proscenium wall, which in itself is a major construction project, and in some cases will require the moving of the projection booth. The drive-in theaters are already at work enlarging screens to the CinemaScope aspect ratios. Here again the short focal length lens problem is encountered, and in many cases we find it necessary to move the projection booth to the back ramp in order to use long focal length lenses and thus improve the definition on the screen. This work and equipment are necessary for good projection, glamour and showmanship in the presentation of CinemaScope pictures.

In conclusion, we evaluate the new processes as having been confused, from Cinerama through 3-D, VistaVision and the various "Scopes." Although the new processes gave the shot in the arm needed to help and probably save the film industry, more rapid progress could have been made, and improvement could still be made if the various producers with their technicians would get together and consolidate the best features of all processes, thus standardizing on one process that would be flexible in some respect so that it could be adapted to any theater. This would help the producer, exhibitor and manufacturer to produce better pictures with improved features that could be presented with good showmanship on better equipment.

Standardization at this time would probably remove the confusion that exists in the minds of people in the film industry as well as the public, but do not let standardization stop research, which must continue at all times.

System for Automatic Additive Printing and Scene Testing of Color Film

By FRANK P. HERRNFELD

This paper describes a system for additive printing of positive color release film. The system consists of an additive Scene Tester, a conversion of a Model D Bell & Howell printer, and a control system making the modified printer completely automatic.

For successful printing on Monopack color release film, the reproduction must not only be natural or pleasing, but it must also be economically feasible. It should be possible to view dailies on the screen with a time lapse similar to that of a black-and-white production. Color film and its processing are too expensive to permit undue waste. Timing by eye, though possible, is not practical as the loss of time, labor and film is too great.

Last, but not least, the speed of printing and labor expended upon it must be held to a minimum in order to compete with other color systems.

This paper treats the additive printing system only. It does not attempt to compare it to any other system.

By additive printing is meant that three light sources, each being pseudo-monochromatic in the red, green and blue, are superimposed onto the film for printing purposes as against subtractive printing, which uses a single light source modified by appropriate color-correction filters.

Presented on October 22, 1954, at the Society's Convention at Los Angeles by Frank P. Herrnfeld, Frank Herrnfeld Engineering Corp., 5880 Blackwelder St., Culver City, Calif.
(This paper was received on January 24, 1955.)

General Description

The system consists of an additive Scene Tester, a punch and die to make the tape for carrying the necessary printing information, a pickup unit operated automatically by the contactor on the printer, and the optical system with automatic intensity control.

Although it is possible to print additively with a single light source, we found that a three-light-source system is far more flexible, and easier to adjust and to maintain. With the light filters furnished, each source can be considered essentially monochromatic. Interference filters by themselves are not suitable for printing color film because their cutoff is not complete and the bandwidth is too broad. Additional glass or gelatine filters, hereafter called color trimmers, have to be used to eliminate the unwanted transmission of the interference filters. The band of light transmitted by the interference filters in conjunction with the color trimmers is sufficiently narrow that changing the color temperature of the source over several hundred degrees Kelvin will not affect the color transmitted. By adjusting the light output of each individual source, differences in speed in the three emulsion layers can be compensated for, thus eliminating compensating filters for different emulsions. The two interference filters and color trimmers were selected to produce a spectrophotometric curve with characteristics of the gelatine filters recommended by W. T. Hanson, Jr., and W. I. Kisner.[1] The interference filters are treated in detail by Mary Ellen Widdop.[2]

The peak transmissions fall at 425, 545 and 690 mμ respectively. Figure 1 shows the difference in transmission characteristics of the filters used and those of the filters recommended by Hanson and Kisner. The solid lines depict the interference filters and color trimmers and the broken lines the gelatine filters. Both sets of filters were measured and plotted using a tungsten lamp burning at 3000 K as a source modified by a Pittsburgh 2043 4-mm heat-absorbing glass.

Scene Tester

The optical schematic of the Scene Tester is shown in Fig. 2. The optics used are essentially the same as used in our Model 1531-C sensitometer modified for this purpose.

The schematic is shown in simplified form and omits the necessary interlocking devices. The filament of the lamp is picked up by the condenser lenses and focused into the second objective lens. The front of the condenser is picked up by the objective lens and focused by a rotating first-surface mirror onto the film plane. The mirror is located in the center of the optical axis and scans the film plane, located as an arc around the optical axis, at an even rate.

Between the lamp and first condenser is a fire shutter. Each shutter is synchro-

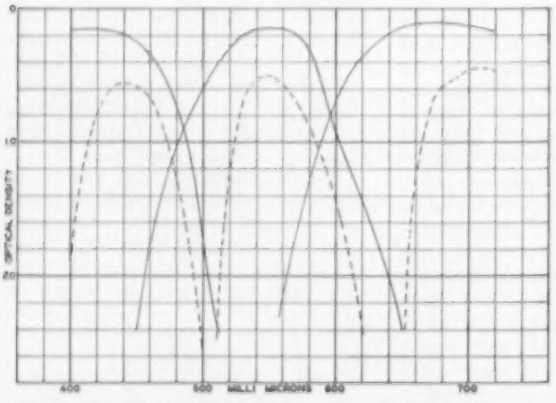


Fig. 1. Graph of the difference in transmission characteristics of the filters used and those of the filters recommended by W. T. Hanson, Jr., and W. I. Kisner. The solid lines depict the interference filters and color trimmers and the broken lines the gelatine filters. Both sets of filters were measured and plotted using a tungsten lamp burning at 3000 K as a source modified by a Pittsburgh 2043 4-mm heat-absorbing glass.

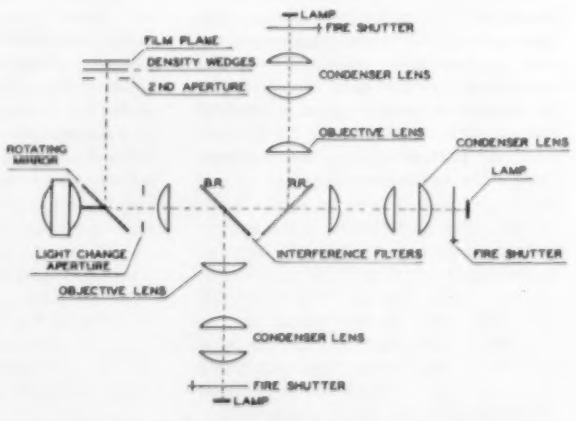


Fig. 2. Optical schematic of the Scene Tester.

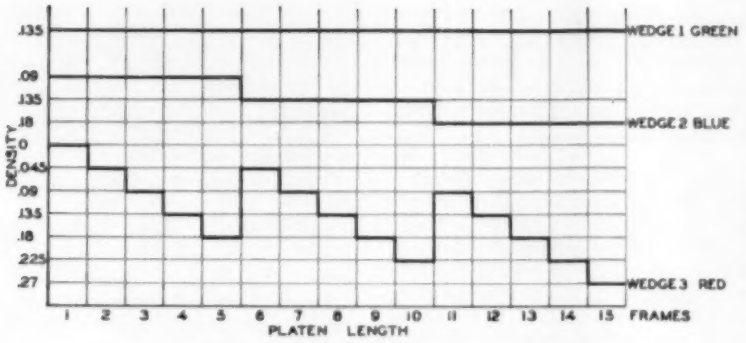


Fig. 3. Outline of Scene Tester wedges.

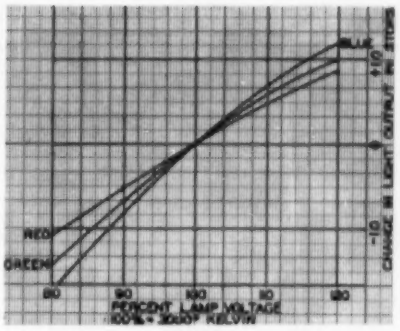


Fig. 4. Light output vs. lamp voltage.

nized with one of the three density wedges. That is, the green fire shutter opens only if the "green" density wedge is in place, the blue shutter only if the "blue" density wedge is in place, etc. The first aperture and heat-absorbing glass are located between the first and second condenser in a collimated light beam. The interference filters are located between the first and second objective lenses. They are similar to those used in the printer. The lamp furnishing the blue part of the spectrum for printing purposes is located at the lower left center of Fig. 2. The blue light is reflected by the blue-reflecting interference filter to be used for exposing the film whereas the red and green light passes straight through. The lamp supplying the red light is located at the upper right center. The red light is again reflected onto the film, whereas the blue and green light passes straight through. The lamp furnishing the green is located at the center right. The red part of the spectrum is reflected at the red reflecting interference filter, and the blue at the blue reflecting interference filters; thus only the green part of the spectrum is passed onto the film. The color trimmers and heat-absorbing glasses are located in front of each first objective lens, where space and holders are provided.

If the intensity of the three sources is adjusted to the right proportions, the light appearing at the film plane will appear to the eye or to a panchromatic film as white light. Altering the proportions, one can change at will from white light to the equivalent of sun or tungsten light. In adjusting the light to any given proportion, one should not use an ordinary light or color meter, unless the meter has been specially calibrated. The reason for this is that a light or exposure meter will not respond equally to radiations of different wavelengths. The instrument must be capable of reading the radiation of each source in reference to the sensitivity of the film.

A light-change aperture is located at the second element of the objective lens. This aperture is calibrated to coincide with the exposure scale of the printer that is teamed with the Scene Tester.

Between the objective lens and the film plane are located a third aperture and the three density wedges. The third aperture is for the adjustment of exposure time. This enables the Scene Tester to match any printer having an exposure time between 1/20 and 1/100 sec. The three density wedges are located on the periphery of a drum near the film plane. Each wedge covers approximately one third of the drum. The timing system is adjusted in such a manner that wedge 1, Fig. 3, is in the light beam covering all fifteen frames during the green exposure cycle; wedge 2, made up of three different densities, covers the fifteen frames during the blue exposure cycle, and wedge 3, made up of fifteen individual densities, covers the fifteen frames during the red exposure cycle.

From Fig. 3 it is seen that during one complete cycle each frame has a different combination of exposures due to the different density combinations of the wedges. Frame 8 carries the same density in wedges 1, 2 and 3. This frame, in conjunction with the setting of aperture 2, coincides with the light setting of the printer.

Steps of log E .045 may seem coarse when the gamma of the film is greater than 3.0, but making them smaller would either restrict the use of the Scene Tester, or require too long a test strip. In actual operation, it will be found necessary to make several exposures at different light settings to get one correct exposure. Experience will reduce the number to a reasonable point in a short time.

A green filter modifies the light in the viewing box of the Scene Tester and will be found a great help to the timer in determining the light intensity necessary to print the film to a first approximation.

To determine the light intensity needed to print from a given negative onto a printing film, the color balance of the light source that will print a neutral density neutral on the printing film must first be established. Smaller variations of equal or greater importance, such as faces, can be taken care of when scene-to-scene corrections are determined.

Three calibrated lamps are supplied with the Scene Tester, to be used in the red, green and blue sockets. The wattages of the lamps are chosen so that if used at their rated voltage, the printing light will have the equivalent characteristic of tungsten heated to 3000 K.

If a normally balanced color negative is printed in the Scene Tester onto color positive, the developed positive should have normal balance on frame 8 of the test strip. If a closer match to neutral is obtained at any other step, it will be necessary to adjust the voltage of the lamps until balance is obtained on frame 8. This is done to retain the full range of which the instrument is capable. Figure 4 shows the variation of intensity of a 500-w lamp in the green, blue and red bands for change in voltage. It is plotted in terms of stops versus percentage of voltage.

It is well to remember that increasing the light output from a given lamp can be accomplished only by raising its filament temperature. The average life of a lamp decreases rapidly with increase in the temperature of the filament. Therefore it is advisable to keep the temperature at or below its rated value, i.e., 3000 K. It is better to increase the wattage of the lamp than to use overvoltage. If the lamps are used at rated or less than rated voltage, the average useful life of an average lamp should be in excess of 200 hr. If uncalibrated lamps are used in the Scene Tester, they should be processed in the same manner as any printing lamp before being put into use.

The intensity of each of the three lamps is adjusted by means of three variable transformers and three voltmeters. A saturated-core type of voltage-regulating transformer is interposed between the line and the variable transformers to keep the voltage supply to the transformers constant. Voltage regulation rather than current regulation of the filaments of the lamps has been chosen to make the arrangement most flexible.

Figure 5 shows the electrical schematic. The cycle is as follows: The positive film magazine must be moved to the top of its travel in order to close contactor S4 to lock relay RY2 into place. This is done to assure that the magazine has

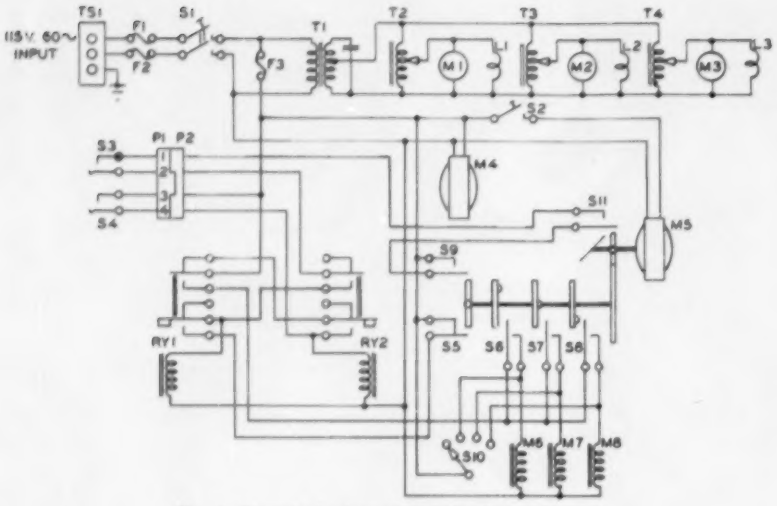


Fig. 5. Electrical schematic of the Scene Tester.

made its full travel. Upon bringing the magazine down into contact with the platen, contactor S3 closes and in turn closes RY1 through S9 and S11 (operated by the cams) and opens RY2, starting the exposure cycle. The cam in turn closes switch S6, opening solenoid M6, the green fire shutter. After a two-third revolution of the mirror holder, the cam opens S6, closing solenoid M6. During the next one-third revolution of the mirror, wedge 1 leaves and wedge 2 moves into place. Next, switch S7 is closed by the cam which in turn energizes solenoid M7, opening the blue fire shutter. This is once more repeated, closing the blue and opening the red fire shutter. The cycle is completed when S5 is opened by the cam and in turn opens relay RY1.

To begin a new cycle, the magazine must again be brought to the top of its travel, at the same time rolling up the exposed film and feeding unexposed film into position. S2 and S10 are test switches. S2 controls the motor, S10 the three fire-shutter solenoids. All are used for testing and adjusting the Scene Tester statically.

Punch and Pickup Unit

The punch utilizes standard 70mm film for the tape. Nineteen square punches are used to convey all necessary information to the pickup unit. Six punches are used for the green, six for the blue, and six for the red light change mechanisms. The nineteenth is for start and checking light. The film is threaded from the front, under the sprocket, over a tension roller, under the punches, back over the same sprocket. The tension roller keeps a tight loop, ensuring proper placement of the tape in respect to the punches.

Figure 6 shows the start of a punched tape. The nineteenth punch is located between the left edge and the perforation. This punch is used to indicate to the operator of the printer, by lighting a neon light on the pickup unit, that the tape is in place and that the printer is

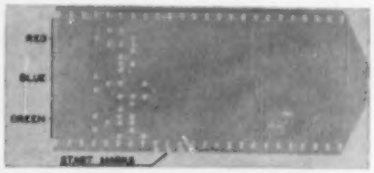


Fig. 6. Start of punched tape.

ready to operate insofar as the automatic light-change mechanism is concerned. It is also used in conjunction with printing cards and footage counter if the automatic system operates properly. If a punch mark is made every sixth or eighth scene, the operator can check during running against the footage counter as to whether the film is being printed in proper sequence and in synchronization.

The other eighteen punches, carrying the information to the three light-change mechanisms, are located between the sprocket holes of the tape. The punches are staggered for mechanical reasons.

The pickup unit works on a power-driven escapement-movement principle and is operated automatically by the contactor of the printer, or manually by a pushbutton located next to the neon light. Nineteen pickup brushes are used and each brush is made up of four evenly spaced leaves. The spacing is such that if information is held over from one scene to another, at least two leaves keep making contact, thus holding the light-change mechanism stationary. The leaves themselves operate solenoids through relays, which in turn insert or remove neutral density filters in the light beams.

Printer Light-Change Mechanism

Figure 7 shows the abbreviated electrical schematic for one of the light-change mechanisms.

With all relays in normal position, i.e. not energized, all neutral densities are in the light beam, reducing the intensity to

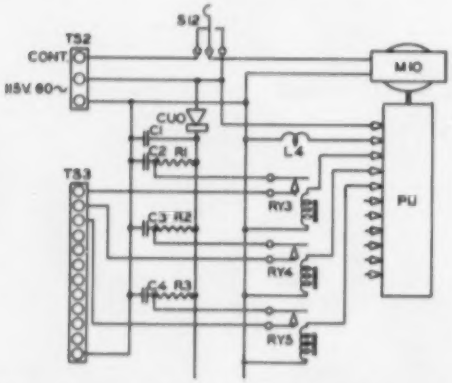


Fig. 7. Abbreviated electrical schematic for one of the light change mechanisms.

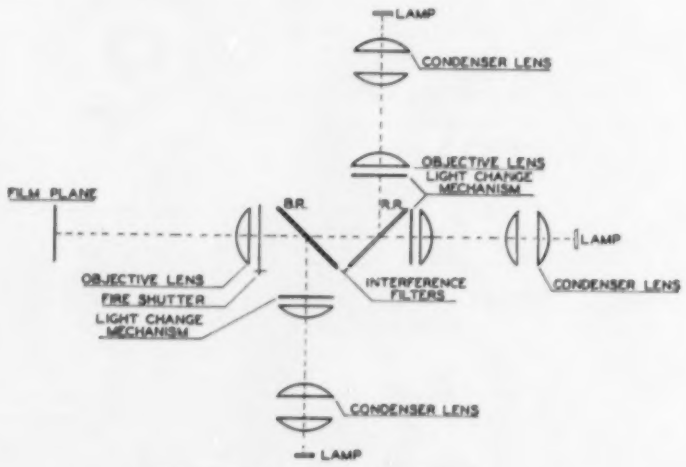


Fig. 8. Optical schematic of the printer.

a minimum. Normally this will reduce maximum light obtainable by about the equivalent in density of 3.15. If RY3 is energized, it will discharge C2 through the light-change solenoid, closing it. R1 will supply sufficient current through the solenoid to keep it closed until RY3 is released. Closing the solenoid will remove a neutral density of 0.05 out of the light beam, thus increasing the light output. RY4 will increase the output by the equivalent of 0.1, RY5 by 0.2, RY6 by 0.4, RY7 by 0.8, and RY8 by 1.6. If a one-stop change should be required, RY4 and RY5 must be energized. Thus, it can be seen that with only eighteen punches, a total of well over 250,000 combinations can be realized.

The light-change solenoids will either close or open within about 20 msec. Thus, any change will take less than one-third frame when the printer is running at 60 ft/min or about one-half frame when running at 90 ft/min.

Printer Optical System

Figure 8 shows the optical schematic of the printer. It can be seen that the optical system is nearly identical to the one used in the Scene Tester. The only difference between the two systems is that the adjustable aperture at the objective of the Scene Tester has been replaced by the three light-change mechanisms in the printer.

The efficiency of the two systems is the same. Sufficient forced air is supplied to dissipate 2000 w in the lamphousing. The optical system is mounted in a new lamphouse replacing the old one on the Bell & Howell Model D Printer.

Unevenness of illumination is less than 0.02 log E across the full aperture for each color and for white light. An average color negative Eastman type 5247 (35mm) may be printed onto color positive stock at 60 ft/min at light 32 (64 available) without exceeding the rated voltage of the lamps.

References

1. W. T. Hanson, Jr., and W. I. Kisner, "Improved color films for color motion-picture production," *Jour. SMPTE, 61:* 667–701, Dec. 1953.
2. Mary Ellen Widdop, "Review of work on dichroic mirrors and their light-dividing characteristics," *Jour. SMPTE, 70:* 357–366, Apr. 1953.

A New Projection Lens

By W. LOTMAR and R. STETTLER

MANY of the conventional projection lenses used for small film projectors are of the Petzval or Voigtländer type shown in Fig. 1. As the Petzval radius of these types is of the order of the focal length, they show considerable field curvature when astigmatism is corrected, or astigmatism when mean field flattening is achieved.

Several attempts have been made to reduce this defect.* More elaborate types comprising three or four members have been introduced, or a Smyth lens near the focal plane has been added. The latter expedient enables the Petzval sum to be made practically zero, but objectives of this type tend to decrease the light flux when an extended source is used owing to the strong dispersing member near the focal plane. Furthermore the rear lens is more easily covered by film dust than in other lens types.

It is well known that field flattening of microscope objectives can be attained by adding one or more thick meniscus lenses. This has been made use of in constructing a new type of projection lens with reduced field curvature (Fig. 2). The front meniscus is afocal and acts as a "wide-angle attachment." The focal length of the objective proper (2nd and 3rd member) is 1.4 × the overall focal length. The Petzval radius of this combination is 2.3 *f* so that field curvature is reduced to about one half that of the conventional lens type. By making the rear face of the meniscus the entrance pupil any vignetting for a field angle of ±9° and a relative aperture of 1:1.4 can be avoided. Spherical and astigmatic correction are shown in Figs. 3 and 4. It is possible also to correct lateral color completely by an appropriate choice of glasses.

A disadvantage of this lens type may perhaps be seen in its relatively great construction length (front apex to back focus) which in the present instance is 2.7 *f*. On the other hand the comparatively large back focus clearance of 0.7 *f* seems to be an advantage for short focal lengths.

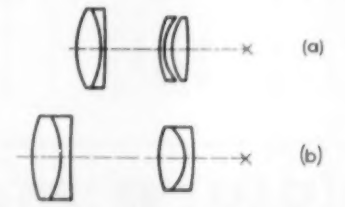


Fig. 1. Conventional projection lenses: (a) Petzval type 1:1.6; (b) Voigtländer type 1:1.6.

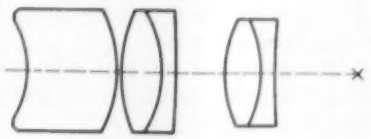


Fig. 2. New projection lens 1:1.4.

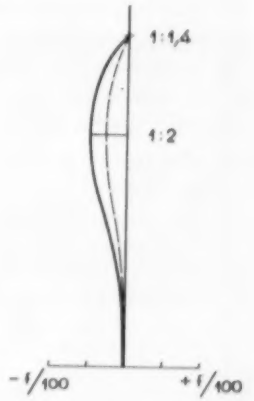


Fig. 3. Spherical aberration of new lens.

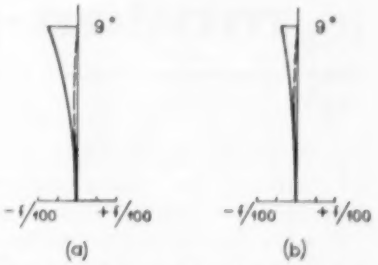


Fig. 4. Astigmatic aberrations: (a) Voigtländer type (Fig. 1(b)); (b) New type (Fig. 2).

A contribution submitted February 1, 1955, by W. Lotmar and R. Stettler, Research Dept., Kern & Co. Ltd., Aarau, Switzerland.

* See, for example, W. E. Schade, "A new *f*/1.5 lens for professional 16mm projectors," *Jour. SMPTE, 54:* 337–344, Mar. 1950.

Proposed SMPTE Recommended Practice

Magnetic Coating of 16mm Magnetic-Photographic Sound Record

A Proposed SMPTE Recommended Practice, Magnetic Coating of 16mm Magnetic-Photographic Sound Record, is published here for a three month period of trial and criticism. All comments should be sent to Henry Kogel, Staff Engineer, prior to August 15, 1955. If no adverse comments are received, the proposal will then be submitted to the Society's Board of Governors for approval as an SMPTE Recommended Practice.

This proposal originated in the Magnetic Recording Subcommittee in April 1953 as a Proposed American Standard. It was revised several times in an attempt to overcome objections raised within the subcommittee. These objections were concerned with the width of the magnetic coating and its location, whether to place it on the inside half or the outside half of the photographic track. Agreement was finally reached on the question of coating width but there was a great deal of hesitancy on standardizing on one particular location, without a good deal more experience to justify one position over the other. However, lack of an industry-wide directive was also considered undesirable. To solve the dilemma, it was agreed to process the proposal in the interim period as an SMPTE Recommended Practice. Unanimity was achieved on this basis and the proposal published here was approved by the Magnetic Recording Subcommittee, Sound Committee and the Standards Committee.—*H.K.*

1. *Scope*

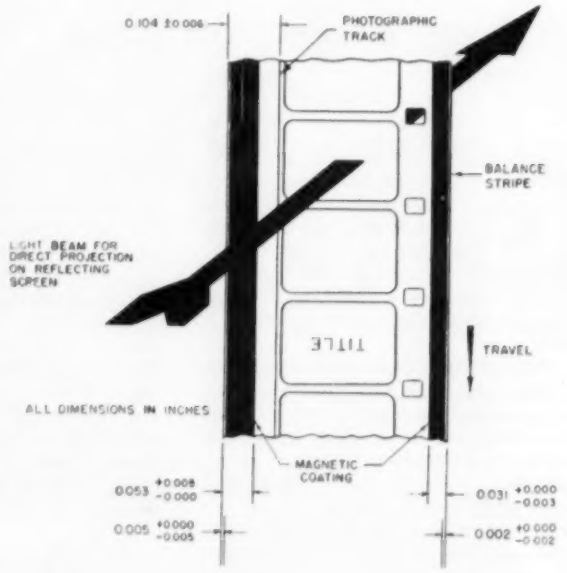
1.1 This Recommended Practice specifies the dimensions and location of the magnetic coating which is applied to 16mm prints containing picture and photographic sound for the purpose of employing both a magnetic sound and the existing photographic sound record.

2. *Magnetic Coating*

2.1 The dimensions and location of the magnetic coating is specified in the diagram below.

2.2 The magnetic coating shall be on the side of the film toward the lamp on a projector arranged for direct projection on a reflection type screen.

NOTE: 1. This is not recommended for unilateral variable area track.
2. The balance stripe is optional.
3. It is essential that American Standard Z22.41-1946, or latest revision thereof, be followed in recording the photographic sound.



motion-picture standards

On the following pages is published a new American Standard: PH22.99-1955, 35mm Magnetic Azimuth Alignment Test Film; and revisions of three existing standards: PH22.42-1955, 16mm Sound-Focusing Test Film; PH22.45-1955, 16mm 400-Cycle Signal-Level Test Film; PH22.57-1955, 16mm Buzz-Track Test Film.

These four standards and the history of their development were published in the February 1954 Journal. It should be noted that each of the standards as approved by the American Standards Association and published herein differ to a greater or lesser degree from the standards previously published for trial and comment.—*H. K.*

American Standard

16mm Sound-Focusing Test Film

ASA
Reg. U.S. Pat. Office
PH22.42-1955
Revision of Z22.42-1946

*UDC 778.5

1. Scope

1.1 This standard specifies a test film to be used for checking the focus of the scanning beam of 16mm sound motion-picture projectors.

Type A — 7000-cycle recording for manufacturing and precision adjustment of sound focusing;

Type B — 5000-cycle recording for quick field adjustment of sound focusing.

2. Test Film

2.1 The test film shall have an originally recorded variable-density sound track heavily overmodulated and developed to high contrast so that the resultant track is essentially a square-wave track.

2.2 The sound track shall have correct azimuth to within ± 5 min of arc.

3. Film Stock

3.1 The film stock used shall be of the low-shrinkage, safety type, cut and perforated in accordance with American Standard PH22.12-1953, Dimensions for 16mm Film, Perforated One Edge, or the latest revision thereof approved by the American Standards Association, Incorporated.

4. Identification

4.1 Each film of Type A shall be marked **ASA — PH22.42 — 7000-Cycle Focusing.** Each film of Type B shall be marked **ASA — PH22.42 — 5000-Cycle Focusing.** This marking shall be printed lengthwise in the picture area, the spacing between consecutive titles to be approximately 12 in.

5. Film Length

5.1 The film shall be supplied in 100-ft lengths.

NOTE: A test film in accordance with this standard is available from the Society of Motion Picture and Television Engineers.

Approved February 2, 1955, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

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70 East Forty-fifth Street, New York 17, N.Y.

Printed in U.S.A.
ASA(M55)

Price, 25 Cents

American Standard

16mm 400-Cycle Signal-Level Test Film

ASA
Reg. U.S. Pat. Office
PH22.45-1955
Revision of Z22.45-1946

*UDC 778.5

1. Scope

1.1 This standard specifies a 400-cycle signal-level test film for use in testing 16mm sound motion-picture projection equipment.

2. Test Film

2.1 The test film shall have an originally recorded, direct-playback, positive variable-area sound recording at an amplitude of 0.0480 ± 0.0015 in. Each film shall be measured for amplitude and the measurements shall be made at a point approximately mid-length of the film and at points between 5 ft and 10 ft from each end.

2.2 The frequency of the recording shall be 400 ± 8 cycles per sec.

2.3 The density of the dark portion of the sound track shall be between 1.2 and 1.4. The density throughout the length of the film shall be as uniform as is consistent with the state of the art.

2.4 The combined base and fog density shall be 0.05 ± 0.01, measured as diffuse transmission density in accordance with American Standard Z38.2.5-1946, Diffuse Transmission Density, or the latest revision thereof approved by the American Standards Association, Incorporated.

2.5 The total harmonic distortion of the recording shall not exceed 5% and the fluctuation of the recorded level shall not exceed 2%.

2.6 Each film shall be run in a calibrated reproducer for the purpose of obtaining the level of recording; this level shall be compared with that of the controlled film of known characteristics and the difference shall be noted in the booklet furnished with each film.

3. Film Stock

3.1 The film stock used shall be of the low-shrinkage, safety type, cut and perforated in accordance with American Standard PH22.12-1953, Dimensions for 16mm Film, Perforated One Edge, or the latest revision thereof approved by the American Standards Association, Incorporated.

4. Identification

4.1 Each film shall be marked **ASA — PH22.45 — 400-Cycle Signal Level.** This marking shall be printed lengthwise in the picture area, the spacing between consecutive titles to be approximately 12 in.

5. Film Length

5.1 The film shall be supplied in 100-ft lengths.

NOTE: A test film in accordance with this standard is available from the Society of Motion Picture and Television Engineers.

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ASA(M55)

Price, 25 Cents

American Standard

16mm Buzz-Track Test Film

ASA
Reg. U.S. Pat. Office
PH22.57-1955
Revision of Z22.57-1947

*UDC 778.5

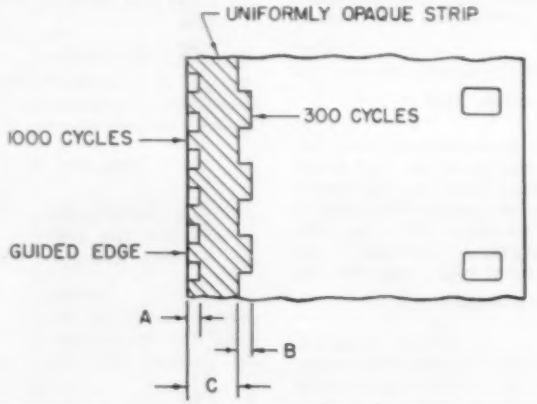
1. Scope

1.1 This standard specifies a buzz-track test film used for checking the lateral position of the sound scanning beam in 16mm motion-picture sound reproducers.

2. Test Film

2.1 The test film shall have originally recorded 300-cycle and 1000-cycle signal tracks on opposite sides of the central exposed strip as shown in the drawing.

2.2 The position of the tracks, weave in running film on the recorder included, shall be in accordance with the dimensions given in the table below:



Dimension	Inches	Millimeters
A	$0.0200 \begin{smallmatrix} +0.0005 \\ -0.0000 \end{smallmatrix}$	$0.510 \begin{smallmatrix} +0.012 \\ -0.000 \end{smallmatrix}$
B	0.018 ± 0.001	0.460 ± 0.025
C	$0.0960 \begin{smallmatrix} +0.0000 \\ -0.0005 \end{smallmatrix}$	$2.440 \begin{smallmatrix} +0.000 \\ -0.012 \end{smallmatrix}$

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ASA5/M55

Price, 25 Cents

American Standard

35mm Magnetic Azimuth Alignment Test Film

ASA
Reg. U.S. Pat. Office
PH22.99-1955

*UDC 778.5

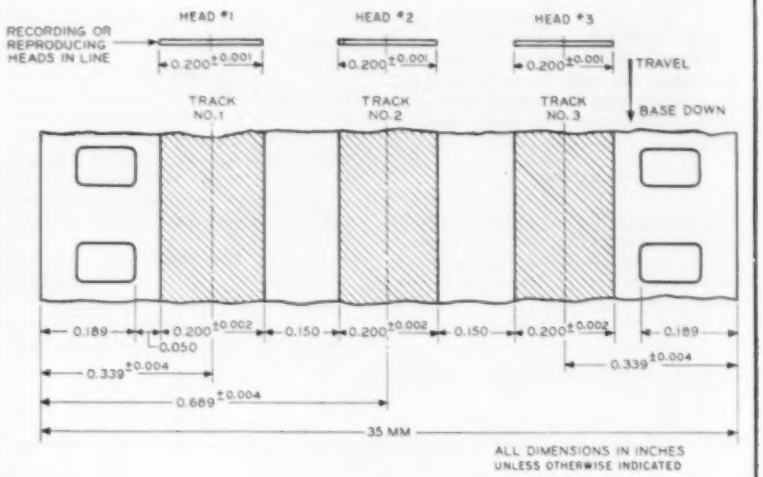
1. Scope

1.1 This standard specifies a test film to be used in aligning the azimuth of magnetic heads on 35mm magnetic recording and reproducing equipment where the head width is not greater than 0.200 in. and where the dimensions and location of the soundtracks are in accord with American Standard PH22.86-1953, Dimensions for 200-Mil Magnetic Sound Tracks on 35mm and 17½mm Motion-Picture Film, or the latest revision thereof approved by the American Standards Association, Incorporated.

2. Test Film

2.1 The test film shall have an original recording of an 8000-cycle sinusoidal tone with a film rate of 96 perforations per sec or approximately 90 ft per min.

2.2 Three sound records shall be recorded in accordance with the dimensions specified in American Standard PH22.86-1953, Dimensions for 200-Mil Magnetic Sound Tracks on 35mm and 17½mm Motion-Picture Film, or the latest revision thereof approved by the American Standards Association, Incorporated, and as shown in the drawing.



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ASA5/M55

Price, 25 Cents

Page 2 of 2 pages

PH22.99-1955

3. Film Stock

3.1 The film stock used shall be of the low-shrinkage, safety type, cut and perforated in accordance with American Standard PH22.36-1954, Dimensions for 35mm Motion-Picture Positive Raw Stock, or the latest revision thereof approved by the American Standards Association, Incorporated.

4. Film Length

4.1 The film shall be supplied in 50-ft lengths or multiples thereof.

5. Identification

5.1 Each test film shall have suitable identification markings.

2.3 The azimuth sound record shall be perpendicular to the direction of film travel within ± 3 min of arc.

2.4 The recorded level at 8000 cycles shall be that level which results from an input current to the magnetic head which is 1 db below the 400-cycle current input which would give a total harmonic distortion of 2½% when that 400-cycle tone is reproduced.

2.5 The coated side and direction of travel shall be as specified in American Standard PH22.86-1953, or the latest revision thereof, and the base shall be coated from one row of perforations to the other row, or from edge to edge.

Proposed American Standard: PH22.97, 200-mil Magnetic Sound Record on 16mm Film Base Perforated One Edge

A Proposed American Standard, PH22.97, 200-Mil Magnetic Sound Record on 16mm Film Base Perforated One Edge, is published here for a three month period of trial and criticism. All comments should be sent to Henry Kogel, Staff Engineer, prior to August 15, 1955. If no adverse comments are received, the proposal will then be submitted to ASA Sectional Committee PH22 for further processing as an American Standard.

This proposal was submitted to the Magnetic Recording Subcommittee in May 1952. Upon approval by the subcommittee, this first draft was submitted to the Sound Committee in November 1952. Several objections to the proposal were received at this point and the proposal was returned to the subcommittee for further consideration. A second draft was prepared and submitted to the subcommittee in April 1954. This second draft was approved with complete unanimity by the Magnetic Recording Subcommittee, the Sound Committee and the Standards Committee and is the draft published now for comment.

Page 2 of 2 pages

PH22.57-1955

2.3 The central exposed strip and the exposed portions of the two signal tracks shall have a density of $1.6^{+0.4}_{-0.0}$

3. Film Stock

3.1 The film stock used shall be of the low-shrinkage, safety type, cut and perforated in accordance with American Standard PH22.12-1953, Dimensions for 16mm Film, Perforated One Edge, or the latest revision thereof approved by the American Standards Association, Incorporated.

4. Identification

4.1 Each film shall be marked **ASA — PH22.57 — Buzz-Track**. This marking shall be printed lengthwise in the picture area, the spacing between consecutive titles to be approximately 12 in.

5. Film Length

5.1 The film shall be supplied in 100-ft lengths.

NOTE: A test film in accordance with this standard is available from the Society of Motion Picture and Television Engineers.

Proposed American Standard

200-Mil Magnetic Sound Record on 16mm Film Base Perforated One Edge

(Second Draft)

PH22.97

1. Scope

1.1 This standard specifies the location, dimensions and recording speed of a 200-mil magnetic sound record on 16mm motion-picture film base with perforations along one edge.

1.2 The film is normally used for sound without picture.

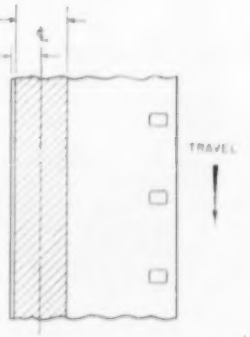
1.3 The dimensions of the magnetic coating is not specified here but is assumed to be wide enough to permit the placement of a sound record in accordance with this standard.

2. Sound Record

2.1 The location and dimensions of the sound record shall be as shown in the drawing.

2.2 The recording speed shall be 24 perforations per second (approximately 36 ft per minute).

2.3 With the direction of travel as shown in the drawing, the magnetic coating is on the upper side of the film base or in other words toward the lamp on a projector arranged for direct projection.



3. Film Base

3.1 The film base used shall be of the low-shrinkage safety type, cut and perforated in accordance with American Standard PH22.12-1953, Dimensions for 16mm Film, Perforated One Edge.

NOT APPROVED

Letter to the Editor

Re: A New Fastax Camera

In Mr. Waddell's recent paper[1] the following statement on optical design is to be found on page 625, top of the second column under the heading "Sprocket":

"The curvature of this sprocket face very nearly matches the change in back focus created by the oblique rays as they pass through the prism."

In reality, the sprocket design has to be related to very different conditions which are not limited to the prism alone. The cylindrical curvature of the film has to be compared with the axially symmetrical curvatures of field produced by both the lens and the prism.

Without going into mathematical details, an important aspect of optical correction in high-speed cameras can be explained by considering these curvature relationships. In rotating prism high-speed cameras the vertical aperture is generally much smaller than the horizontal aperture, so that the latter will determine the optical aberrations. The horizontal aperture represents a tangential beam along the horizontal section through the film, but it represents a sagittal beam for points along a vertical section through the film. Due to the cylindrical sprocket curvature, the optical design should balance the astigmatism of the prism and the cylindrical curvature of the film on the one side with the astigmatism of the camera lens on the other side. The following two conditions have to be fulfilled:

(A) The resultant saggital curvature of field produced by the lens and the prism together should equal the sprocket curvature.

(B) The resultant tangential field of lens and prism together should be flat.

In the case of the Fastax cameras the above conditions may require a lens with negative Petzval curvature.

In addition to these remarks, may I refer to my proposal of a gearless high-speed camera,[2] in which the cylindrical curvature of the film is concave (i.e. opposite to the convex film curvature in the Fastax cameras). This gearless feature has the particular advance, among others, that the optical correction for the concave cylindrical film curvature can be conveniently achieved in connection with a camera lens having positive Petzval curvature.

The convex sprocket curvature in Fastax cameras is an inherent drawback of the geared system, representing hardly manageable conditions from the point of view of the feasibility of optical correction.

References

1. J. H. Waddell, "Full-frame 35mm Fastax Camera," *Jour. SMPTE, 61:* 624–627, Nov. 1953; an integral part of the few closely related publications is: J. H. Waddell, "Errata," *Jour. SMPTE, 57:* 82–83, July 1951, which item was omitted in the Bibliography on High-Speed Photography, *Jour. SMPTE, 61:* 749–757, Dec. 1953.
2. John C. Kudar, "Optical problems in high-speed camera design," *Jour. SMPTE, 58:* 487–490, June 1952.

September 14, 1954 John C. Kudar
Rua São Francisco 93
Curitiba, Paraná, Brazil

news and reports

Papers Program 78th Convention

The general theme of the program for the 78th Semiannual Convention at Lake Placid, October 3–7, 1955, will be "COLOR IN MOTION PICTURES AND TELEVISION." It is felt that a theme involving color is particularly appropriate and in harmony with the beauty of nature at Lake Placid in early October.

Several round table discussions are being planned to attempt to evaluate some of the trends of the industry in regard to studio and laboratory practice, projection and viewing aspects, high-speed photography applications and television practice. The round table discussions will be conducted by leaders in several fields of activity.

It is planned to have a smaller number of papers than usual on the technical papers program and an attempt will be made to select subjects of timely interest in line with the general theme. A restricted papers program will permit those attending the meeting to have more time for discussion both at the sessions and in private conferences.

The Papers Committee invites your thoughtful consideration of the plans for the Fall Meeting and welcomes your suggestions with regard to subjects for papers. Author's forms may be obtained from the Chairman or anyone of the following committee members or from Society headquarters.

I. *Materials and Their Uses*, Glenn E. Matthews, Research Laboratories, Eastman Kodak Co., Rochester 4, N.Y.

II. *Studio Practice*, Arthur C. Blaney, Radio Corp. of America, 1560 N. Vine St., Hollywood 28, Calif.

III. *Laboratory Practice*, Gordon A. Chambers, Motion Picture Film Dept., Eastman Kodak Co., 343 State St., Rochester 4, N.Y.

IV. *Projection and Viewing*, Dr. Charles R. Daily, Paramount Pictures Corp., 5451 Marathon St., Hollywood 38, Calif.

V. *Television Practice*, T. Gentry Veal, Research Laboratories, Eastman Kodak Co., Kodak Park, Rochester 4, N.Y.

VI. *High-Speed Photography Symposium*, John H. Waddell, Fairchild Camera and Instr. Corp., 88-06 Van Wyck Expressway, Jamaica 1, N.Y.

Deadline date for titles and abstracts is August 1. It would be much appreciated, however, if authors would complete the author's form and send the copies in by July 1 as this will assist the Committee in the planning of the final program.

Papers will also be considered on non-color aspects of motion pictures and television.—*Glenn E. Matthews*, Program Chairman, 78th Convention.

The 77th Convention

The 77th was one of Chicago's greatest and a lot of kudos is due to the people who worked all week long behind the scenes to keep it rolling.

The Papers Program was under C. E. Heppberger who had great support from special subject chairmen — Dick Painter for high-speed photography, John Ditamore

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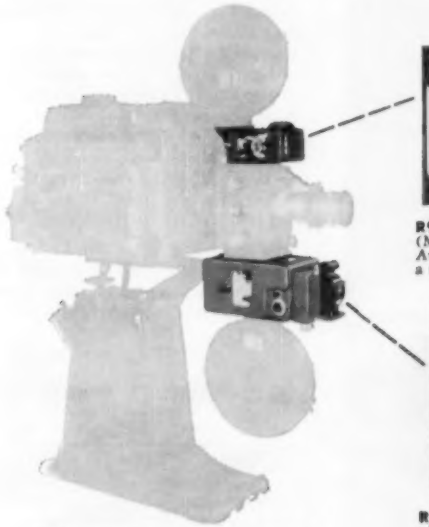
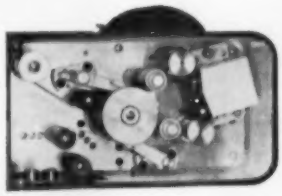
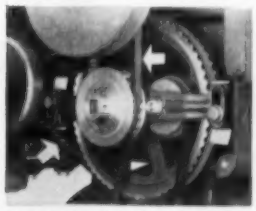


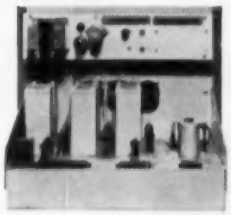
THE WESTREX R9 Stereophonic Reproducer (Magnetic) and R7 Photographic Reproducer.



R9 STEREOPHONIC REPRODUCER (Magnetic) brings you the Academy Award winning hydro flutter suppressor, a tight film loop, and double flywheels.



R7 PHOTOGRAPHIC REPRODUCER gives unsurpassed reproduction from variable area and density prints. Special noiseless timing belts are an exclusive feature . . . will not slip or stretch.



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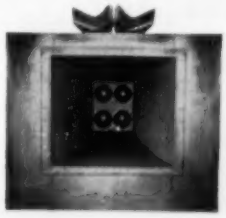

THE WESTREX T502B Stage Loudspeaker Assembly was designed for larger motion picture theatres.

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for nontheatrical motion-picture subjects, and Bill Kusack for television. Ken Mason as motion-picture short subjects chairman had all the film shorts in order early so that all were listed by title and studio in the Final Program.

The Program was a very big one — 71 papers. Defaults were few: one paper was cancelled at the last minute, one author was ill and failed to arrange for the reading of his paper, and four were read by title only. This was a bang-up program with the high attendance of about 400 reached at the State-Lake Theatre session on wide-screen photography. The nontheatrical motion-picture sessions drew an average of 150 throughout, with other sessions ranging from 50 to 100 in attendance.

Ken Mason, who headed the Registration team, carried the largest burden of work on his capable shoulders. The new idea of preregistration was his and it is expected to become a standard procedure in the future. Ken deserves much credit for his tedious job.

Recording and Projection chairmen Robert Burns and I. F. Jacobsen cracked the whip over their selected crew and "toted the bale" themselves when necessary. Setting up and operating all the equipment is a thankless job, so publicly, our thanks to "Bobby" and "Jake." Helping on recording were Steve Welch, N. W. Rodelius and Earl Platt.

Exhibits at the 77th were highly successful and all praise is due the two men who organized them — George Oakley and Jerry Debish.

Our luncheon went off smoothly with a terrific keynote speech by Chuck Percy, President of Bell & Howell, who spoke on "World-Wide Competition Spurs Trade," a subject which he has elaborated before Congress and the public. He made his subject particularly pointed for his fellow SMPTE members with apt examples from our industry and with practical butter, cheese and oil tanker tales about survival of business abroad. All luncheon arrangements were made by Henry Ushijima with his usual aplomb.

Jerry Diebold put on a banquet which was really the social high spot of the week. The music was danceable, the floor smooth, the atmosphere heady, and a good time was had by all. Many thanks, Jerry.

Publicity — and Miss SMPTE — came from the fertile pen of Ed Seguin ably assisted by Bob McIntyre. Messrs. McDonald, Docterman and Case comprised Ed's committee.

Hotel arrangements were completed by Larry Hanchek and our thanks to all the Central Section people who pitched in and did such a swell job — people like Harry Lange, George Colburn, Bob Herbst, Dave Ridgway and Reid Ray.

And last our thanks to the Ladies' Committee, Mesdames Townsley, Colburn, Diebold, Ray, Mason, Hanchek, Heppberger, Ushijima and Wassell.—*James L. Wassell.*

Editorial Note: The 77th Convention was thoroughly organized and run off under Local Arrangements Chairman Jim Wassell.

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FOR RESEARCH ASSISTANCE WRITE TO:
THOMAS T. HILL, *Director Photographic Research*

FOR TECHNICAL SERVICE WRITE TO:
CHARLES F. LO BALBO, *Motion Picture Technical Advisor*

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section reports

The Pacific Coast Section held its regular monthly meeting on Tuesday, April 19, 1955, at CBS-Television City, Hollywood. The program featured three papers which were concurrently being presented at the Semiannual Convention in Chicago. 170 members attended.

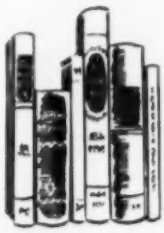
E. H. Bowlds of E. H. Bowlds Engineering Co. gave a paper entitled "Two Animation Stands of New Design." The stands were described as applicable to 16mm and 35mm single-frame or continuous photography of animated sequences. One stand features extremely flexible movements coupled with a precise system of calibrations. The second model, called "Animation Junior," is designed with great simplicity to meet the demands of television stations and nontheatrical producers.

R. A. Lindsay of Jerry Fairbanks Productions presented for Jerry Fairbanks the paper "Use of CinemaScope in 16mm Nontheatrical Films." This paper discussed the problems encountered and the solutions in filming of 16mm CinemaScope films for industrial and educational use. A 16mm CinemaScope film made for Chrysler

Corp. demonstrated the value of the 2.5:1 aspect ratio in presentation of new motor car models. E. Field of Jerry Fairbanks Productions assisted in the projection of the CinemaScope film.

Herbert Meyer of the Motion Picture Research Council, Hollywood, read his paper "Selected Set Construction Techniques." The application of many new chemical products to set production was described and illustrated. Several interesting new plastics were shown to have application in special effects. A 16mm motion picture was used to demonstrate the value of a new reflecting paint for background lighting.

The Society is greatly indebted to the Columbia Broadcasting Co. again this month for their generous provision of a large audience participation studio for this meeting. Lester Bowman of CBS made the arrangements.—*E. W. Templin*, Secretary-Treasurer, c/o Westrex Corp., 6601 Romaine St., Hollywood 38.



books reviewed

Colour Cinematography Third Edition

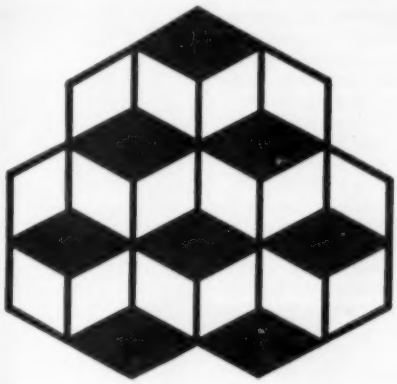
By Adrian Cornwell-Clyne. Published (1951) Chapman and Hall, Ltd. 37 Essex Street, London W.C.2. xvi + 780 pp. 348 illus. Price 84 shillings.

The third edition of *Colour Cinematography* retains the approach and form of the earlier editions but has been greatly expanded in some sections and has been brought up to date as of the time of writing by means of the 12 appendixes. However, the release timing of the publication of this book was unfortunate in that it was just prior to the introduction of the numerous negative-positive, integral-tripack, incorporated-coupler type films which are now widely used.

In Part I, the chapter headings — Historical Summary, The Theoretical Basis, Additive Processes, Subtractive Processes, Colour Cameras and Beam-Splitting Systems, and Bipack, — are the same as in the earlier edition. The historical summary contains an interesting review of the important names, patents and processes tabulated in the form of a family tree going all the way back to Sir Isaac Newton. The chapter, "The Theoretical Basis," has been greatly expanded over the previous edition to include a discussion of the colorimetric standards of the C.I.E. and the recent studies of subtractive color mixture. However, it still contains the original emphasis on light sources and lighting equipment and a great deal of other material which one finds difficult to class as "the theoretical basis."

The chapter, "Subtractive Processes," has also been greatly expanded. A detailed treatment of the Agfacolor Negative-Positive Process, which includes the chemical formulas of the sensitizing dyes and the color-forming couplers, is a compilation of the data found in a number of FIAT reports. The handling of the Ansco Color Reversible Film is also described in great detail. 16mm Kodachrome and its use in the commercial motion-picture field receive 23 pages. The Technicolor Process is given the greatest emphasis and is described in considerable detail (more than 50 pages). A diagram entitled "General arrangement of the 'I.B.' Transfer Machine used for printing Technicolor positives. (Schematic only.)" shows a great deal of the detail of the I.B. process. The chemical formulas of the various processing solutions used, the matrix developer, the dye baths, etc., are given. However, a footnote states: "These data are schematic only and no reliance can be placed on any exact correspondence with present practice."

Part II quite briefly treats pertinent subjects under these headings: Background or Process Projection, Colour Film Sound Tracks, Toning, The Processing of Two-Colour Prints by Deep Tank Methods, The Stereoscopic Picture in Colour, Make-Up, and Colour Sensitometry; and Part III is similarly written under these headings: The Phenomena of Colour Vision and the Making of Films in Colour, Colour Harmony, and Colour Standards: Measurement and Specification.



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In the final section of the book, "The Future of the Colour Film," the author states:

"On re-reading this section of the last edition of this book (in 1939), the author is impressed with the accuracy of many of the predictions then made. It is a fitting moment to review the former material and to make such comments as may be apposite under the present altered condition of the world.

"The question was put: 'Will the colour film altogether supplant the black-and-white film?' Not one word of the reply need be altered. This was the answer: 'It is extremely unlikely that we are about to witness a rapid change-over in picture-making in any way comparable to that which occurred when sound reproduction became available. This statement is made in spite of the daily repeated prophecy that we are in for a revolution in the industry. On the contrary, it is much more likely that the proportion of colour films to black-and-white will gradually, and very gradually, rise during the next five years. It would be very surprising to the writer if in five years from now *one-half of films are made in colour*.' Now the position is that probably not more than one-tenth are made in colour today in 1949, and it will still be surprising to the writer if one-half of all films are made in colour in the year 2000. . . . ."

This and other statements in this section of the book do not recommend the author as a prophet of things to come in color cinematography.

In general this book is a compilation of published material, in many cases the exact reproduction of entire articles. Where much unimportant detail was in the original, it is in this book. Since so much of the material is a compilation apparently it has not been possible to arrive at a clear-cut organization of the material into a consistently presented story. However, the tabulations of the patents in the field of color cinematography (over 600 in Appendix 1) are apparently quite complete and the book will be of importance to those interested in the history of color cinematography.—*W. T. Hanson, Jr.*, Kodak Research Laboratories, Rochester 4, N.Y.

Progress in Photography 1951-1954

Published by the Focal Press, London and New York. Distributed by American Photographic Book Publishing Co., 33 W. 60 St., N.Y. 23. Vol. 2, 336 pp., various illus., 7 × 9 in. Price $10.00.

This is the second volume of an international record of photographic progress, purporting to cover the period from 1951 through 1954. (The first volume covered the period from 1940 to 1950.) A board of editors, consisting of authorities from England, Italy, Switzerland and the United States, obtained the assistance of over 60 specialists to prepare the 11 sections of the book. Each section has an appropriate number of chapters to deal with specific aspects of the main subject headings.

Although among the authors only a few countries are represented, namely, France, Germany, Great Britain, Italy and the United States, a reasonably serious attempt appears to have been made to treat the material at an international level. Certain elements of national prejudice are evident, however.

The scope of the book can be ascertained from a listing of the main sections without a complete enumeration of the individual chapters. The sections appear in the following order: Photographic Equipment; Photographic Theory and Materials; Colour Photography; Photographic Processing; Cinematography; Special Techniques; Special Applications; Radiography and Diffraction; Photographic Business and Industry; Photographic Organizations and Standards; Appendix.

The section on cinematography suffers mostly from not being up to date. The chapter on sound recording, for example, does not cite a reference later than 1952, and the main chapter in the section entitled "Professional Cinematography" has no references later than 1953. As a matter of fact, of the thousands of references given throughout the book, only a handful apply to 1954. This criticism can be put directly in the lap of the publisher because the authors were pressed to have their manuscripts finished by the end of 1952. No doubt the tardiness of some authors delayed publication and allowed these authors to cover a good part of 1953, but on the whole the treatment does not extend beyond 1952.

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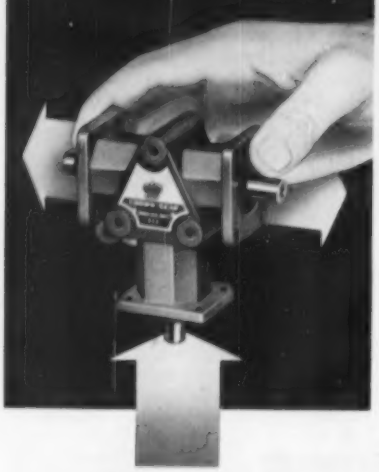

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the discussion to the American reader is that it provides a reasonably current picture of foreign methods, particularly British. However, most motion-picture engineers will find the discussion too general in character. This is not a valid criticism, though, because the book includes such a vast range of subjects that detailed treatments would be impractical. As a matter of fact, the merit of the book derives from the condensation of the subject material, thus providing in each chapter — many of which are but a few pages in length — an easy way to obtain a general picture of the progress made in various areas of photography during the past several years. Every photographic engineer and technician will find it exceedingly useful as a constant reference source.—*Lloyd E. Varden*, Consultant, 200 E. 66 St., New York 21.

L'Ingénieur du Son en Radiodiffusion, Cinéma, Télévision

By V. Jean-Louis. Published by Editions Chiron, 40, rue de Seine, Paris-VI^e^. 292 pp. 6½ × 9½ in. 160 illus. Price 2700 F.

This book contains three main sections: a review of the fundamentals of physical and psychological acoustics, a discussion of sound pickup techniques, and a discussion of the functions and qualifications of the sound engineer. Its major contribution is a description of the position of the sound engineer in the motion-picture, radio and television industries in France, from the point of view of a senior sound engineer.

Errors of carelessness and errors of understanding both appear in the technical material; for example, a velocity of propagation and particle velocity are confused at one point. Elsewhere, the term "velocity microphone" is applied to any moving coil or conductor microphone, with no reference to the fundamental peculiarity of the pressure-gradient microphone, in that the output is related to particle velocity rather than sound pressure. It is also characteristic of a lack of balance that a long discussion of the motion of the microphone ribbon, of no value to the practice of sound pickup, is inserted where a similar discussion of the difference in response of a pressure-gradient microphone to spherical and plane sound waves would explain the increased bass response for close talking, a property of fundamental importance for proper microphone placement.

The discussion of microphone placement follows that of J. P. Maxfield without acknowledgment. It is a delicate matter, about which this reviewer is not fully informed, to decide whether European techniques of microphone placement and studio treatment preceded or followed Maxfield's studies. It is unfortunate, however, to find that an analysis essentially identical with Maxfield's and using his symbols is presented with no reference credit, since his work is said to be well known in Europe.

The last third of the work is a detailed description of an extensive recruiting program carried out by the experimental studio of Radiodiffusion Française, including written tests, listening tests and operating skills tests. The author presents these as proof of the need for such testing methods,

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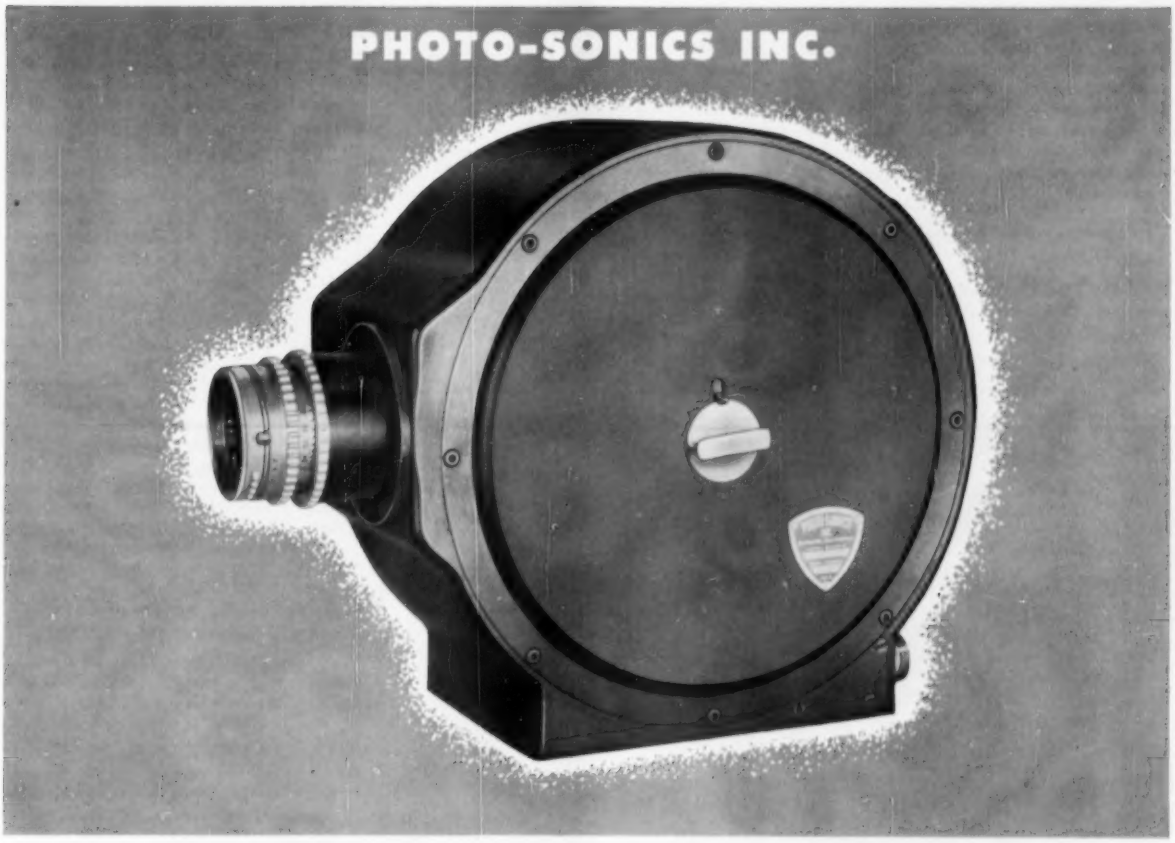

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rather than as a desirable model. It is instructive to note that a great deal of emphasis is placed on musical understanding and knowledge.

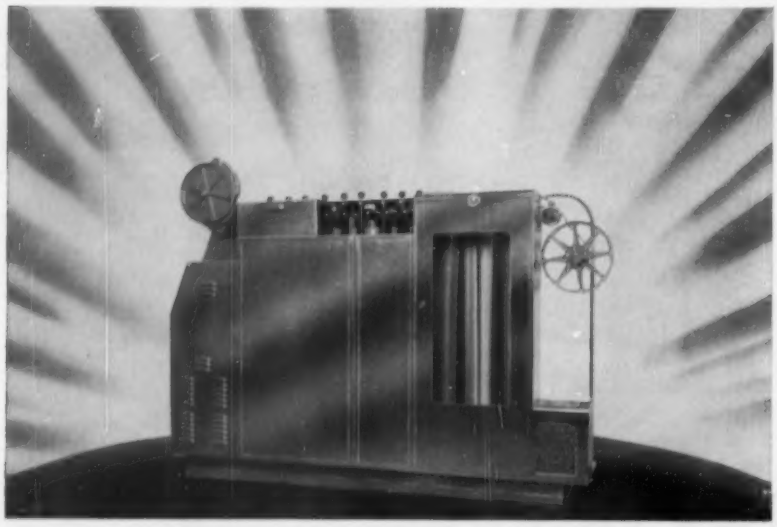
Although the French is clear and simple, this reviewer does not believe that the value of the book justifies the effort of surmounting the language barrier.—*Skipwith W. Athey*, General Precision Laboratory Inc., Pleasantville, N.Y.

Underwater Photography and Television

By E. R. Cross. Published (1954) by Exposition Press, 386 Fourth Ave., New York 16. 258 pp. 72 illus. 5½ × 8 in. Price $6.00.

Current popularity of sub-aquatic motion pictures will find ample material in this purposefully subtitled "Handbook of Equipment and Techniques," written by a professional Master Diver with a twenty year background of underwater photography.

The practical approach of the book makes it a reference text on the subject, with a wealth of technical data on procedures and available facilities. Specific information on cameras, lenses, filters and lighting, as well as diving problems, is given in basic and direct terms, with numerous instances of personal experience. A list of equipment suppliers, a bibliography, a glossary and an index complete this valuable and highly interesting volume.—*George L. George*, Sturgis-Grant Productions, Inc., 322 E. 44 St., New York 17.



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Twenty Years of Cinema in Venice

Edited by Antonio Petrucci. Published (1954) by The Venice Biennial. Distributed in the U.S. by W. S. Heinman, 400 E. 72 St., New York 21. 698 pp. 336 illus. 7 × 10 in. Price $8.50.

Published simultaneously in English, French and Italian editions, this massive volume offers a priceless historical perspective of the crucial years of the motion-picture progress, as reflected in the oldest international film festival.

The evolution of film arts and techniques in the different participating countries is discussed by experts, with Herman G. Weinberg doing a good job for the United States. Specific film-making problems are reviewed in another section, and the chapters devoted to editing and music are noteworthy contributions.

A comprehensive index and a complete list of all the films screened at Venice complete this impressive record of international competition.—*George L. George*, Sturgis-Grant Productions, Inc., 322 E. 44 St., New York 17.

General Bibliography of Motion Pictures

Edited by Carl Vincent, Riccardo Redi and Franco Venturini. Published (1954) by Edizioni dell'Ateneo, Rome. Distributed in the U.S. by W. S. Heinman, 400 E. 72 St., New York 21. 256 pp. 7 × 10 in. Price $6.00.

The need for an up-to-date international bibliography of significant publications devoted to the various aspects of film is abundantly fulfilled by this volume.

The lengthy chapter on motion-picture techniques presents an interesting attempt at dividing the subject into two classes, the "purely mechanical technique relating to the use of apparatus and materials," and the "technical aspects that accompany all creative processes."

Other chapters include, among the standard categories of History, Aesthetics, and Criticism, such novel subdivisions as "Social & Moral Problems," "Legal & Economic Problems," and "Documentation & Anthologies."

Despite many typographical errors, and occasional dilemmas in grasping the transcription of foreign names into Italian phonetics, this book is a most useful and commendable reference work.—*George L. George*, Sturgis-Grant Productions, Inc., 322 E. 44 St., New York 17.

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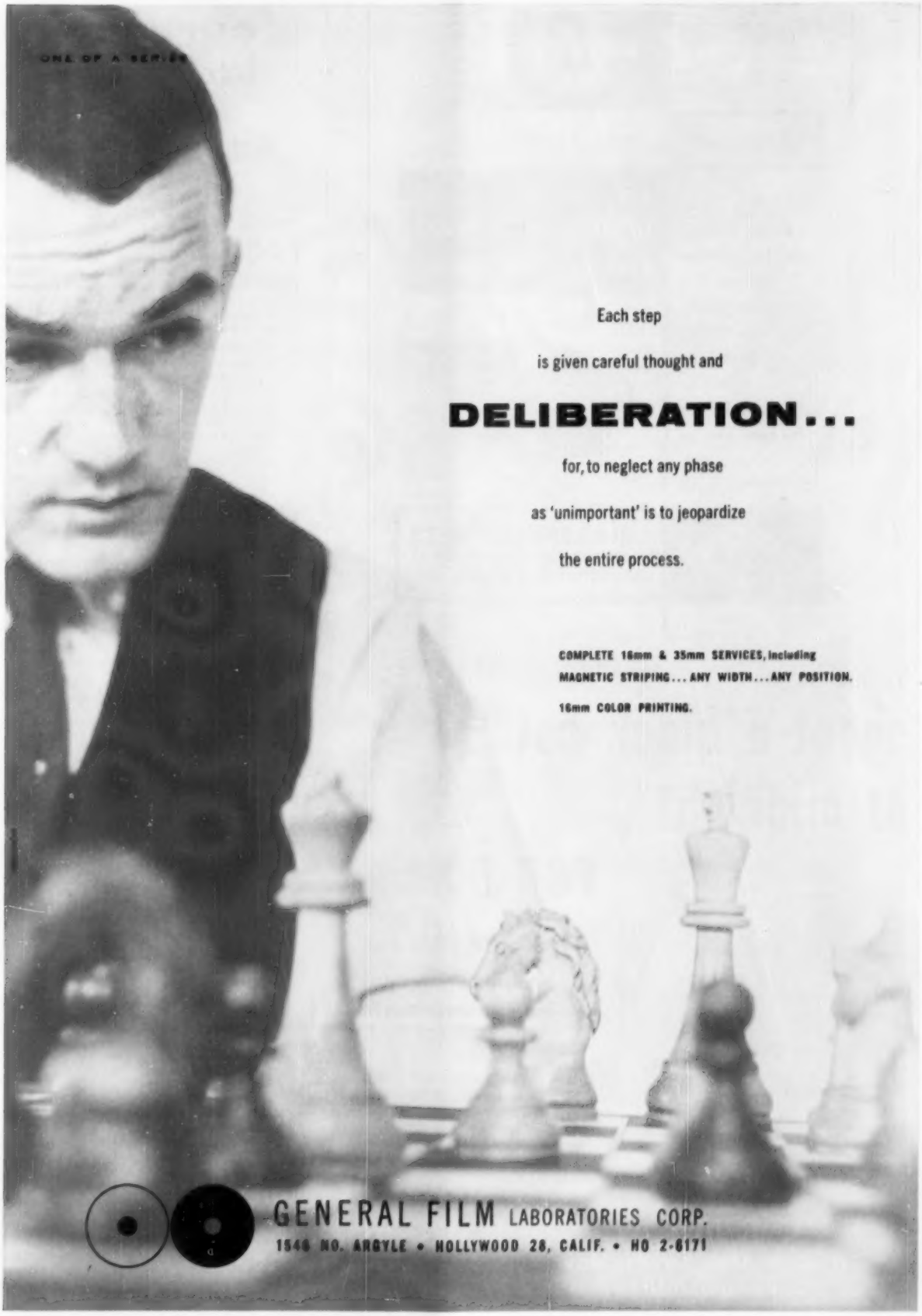
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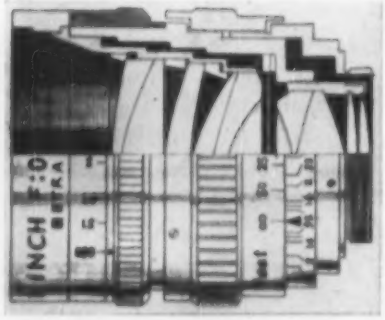

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current literature

The Editors present for convenient reference a list of articles dealing with subjects cognate to motion picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

American Cinematographer vol. 36, Feb. 1955
Visible Edge Numbering of Film Aid to Editing (p. 80) *C. L. Anderson*
The Role of the Camera (p. 82)
Speed in Film Processing (p. 88) *L. Allen*
vol. 36, Mar. 1955
The Video-Film Camera (p. 140) *A. Simon*
Film Unit Operation in the Small TV Station (p. 144) *T. F. Smith*
Laminated Magnetic Sound Tracks for 16mm Films (p. 154) *A. Rescher*

Audio Engineering Society, Journal
vol. 2, No. 4, 1955
Motion Picture Sound Recording at USAF Lookout Mountain Laboratory (p. 204) *H. M. Tremaine*

Bell Laboratories Record vol. 33, Apr. 1955
A New High-Speed Recording System (p. 135) *G. E. Atkins*

Bild und Ton vol. 8, No. 3, 1955
Zur Kenntnis der Farbentwicklung (p. 75)

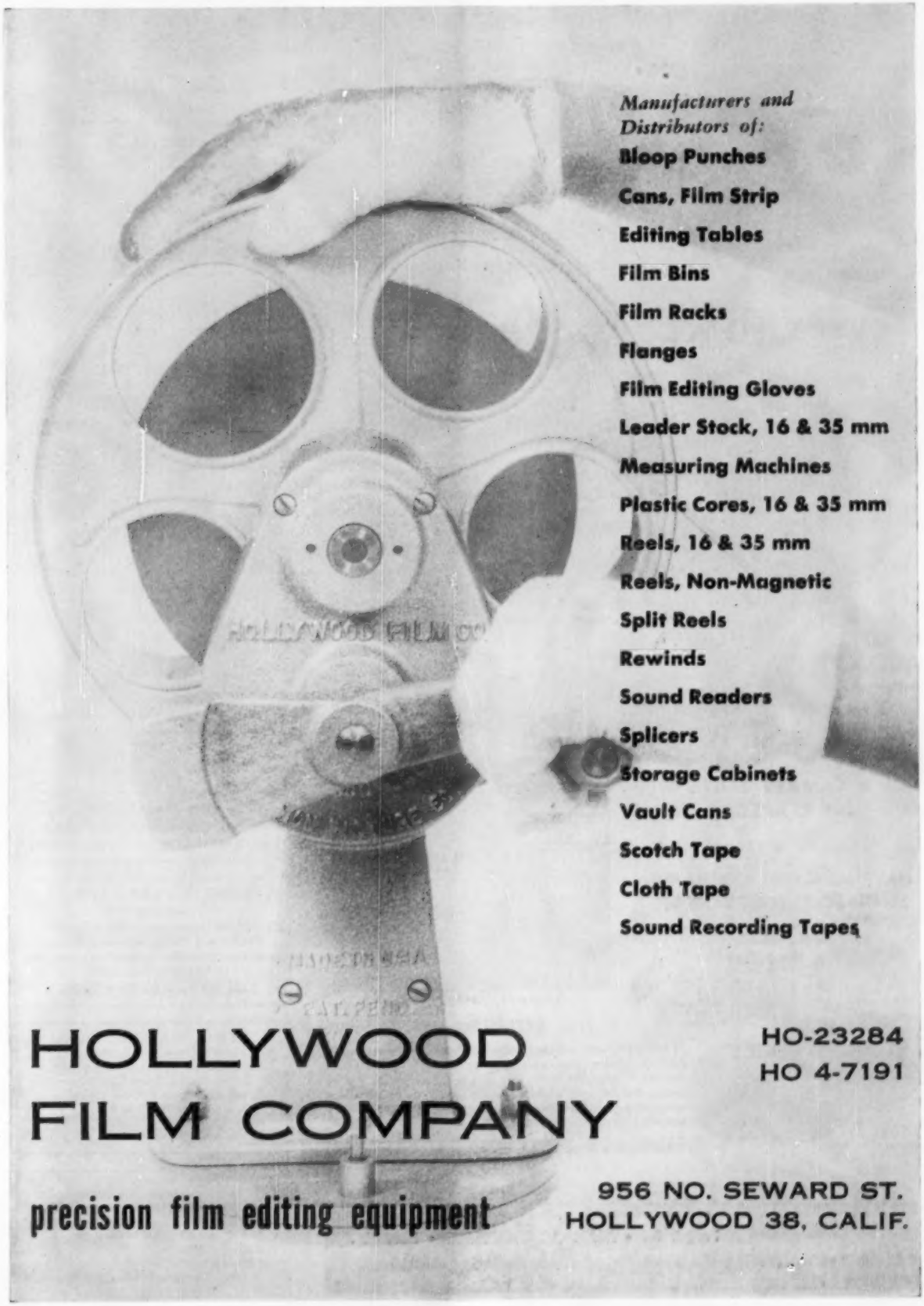
British Kinematography vol. 26, Mar. 1955
Recent Developments in Anamorphotic Systems (p. 61) *G. H. Cook*
Notes on Progress During 1954—Film Production (p. 72)

Electronics vol. 28, Mar. 1955
Studio Amplifier Design for Color Television (p. 154) *J. O. Schroeder*
vol. 28, Apr. 1955
High-Power UHF-TV Uses Grid-Control Tube (p. 130) *L. L. Koros*

Ideal Kinema vol. 21, Mar. 10, 1955
Controlled Reflectivity Improves the Picture (p. 11)

International Projectionist vol. 30, Feb. 1955
A 60-Degree Geneva Intermittent Movement? (p. 7) *J. G. Jackson*
The Todd-AO Projector for Both 70- and 35-mm Film (p. 11)
World-Wide Concern About Technological Standards (p. 13)
Light Sources for Film Projection (p. 14) *R. A. Mitchell*
vol. 30, Mar. 1955
A Novel Film-Splicing Method (p. 7)
Light Sources for Film Projection (p. 14) *R. A. Mitchell*
CinemaScope, Wide Screen Lens Calculations (p. 22) *J. F. Holt*
Ashcraft's New Cinex 170 Arclamp (p. 23) *C. Ashcraft*

Journal of Photographic Science
vol. 3, Jan./Feb. 1955
Some Photographic Techniques in Industrial Electrical Research (p. 10) *A. F. B. Young and D. Lagg*
High Speed Photography in Fluid Kinetics (p. 21) *R. P. Fraser*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Kino-Technik vol. 9, Feb. 1955
Probleme beim Einlagern von Filmen für Archivzwecke (p. 39)
Riesen-Bildschirme oder psychologische Filmkunst? (p. 41) *R. Kohler*
Grundsätzliches zur Wiedergabe räumlicher Filme (p. 43) *W. Metzger*
Formate und Entwicklungstendenzen beim Breitbild (p. 46) *Wilkin*
Grossprojektion als Leistungsprüfung für Projektoren (p. 49)
Aus der Geschichte der Kinematographie. Teil II. (p. 52)
Betrachtungen über die Qualität des Filmbildes (p. 55) *F. Lehmann*

Los Alamos Laboratory AECU-2969, 1954
Fifteen Million Frame per Second Camera (17 pp.) *B. Brixner*

Motion Picture Herald
vol. 198, No. 13, Mar. 26, 1955
Vistavision Plus Optical Illusion = A "Round" Screen (p. 17) *W. R. Weaver*

Philips Technical Review vol. 16, Jan. 1955
The Different Television Standards Considered from the Point of View of Receiver Design (p. 195) *W. Werner*

Tele-Tech vol. 14, Mar. 1955
How to Plan for Color Television Broadcasting. Pt. 2. (p. 96) *L. E. Anderson and W. O. Hadlock*
vol. 14, Apr. 1955
Designing TV Tuners for Color Receivers (p. 80) *F. Schor*
New Design in Closed-Circuit Television (p. 94) *A. V. J. Martin*
How to Plan for Color Television Broadcasting. Pt. 3 (p. 98) *L. E. Anderson and W. O. Hadlock*

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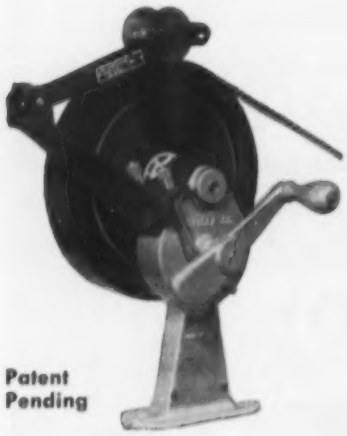

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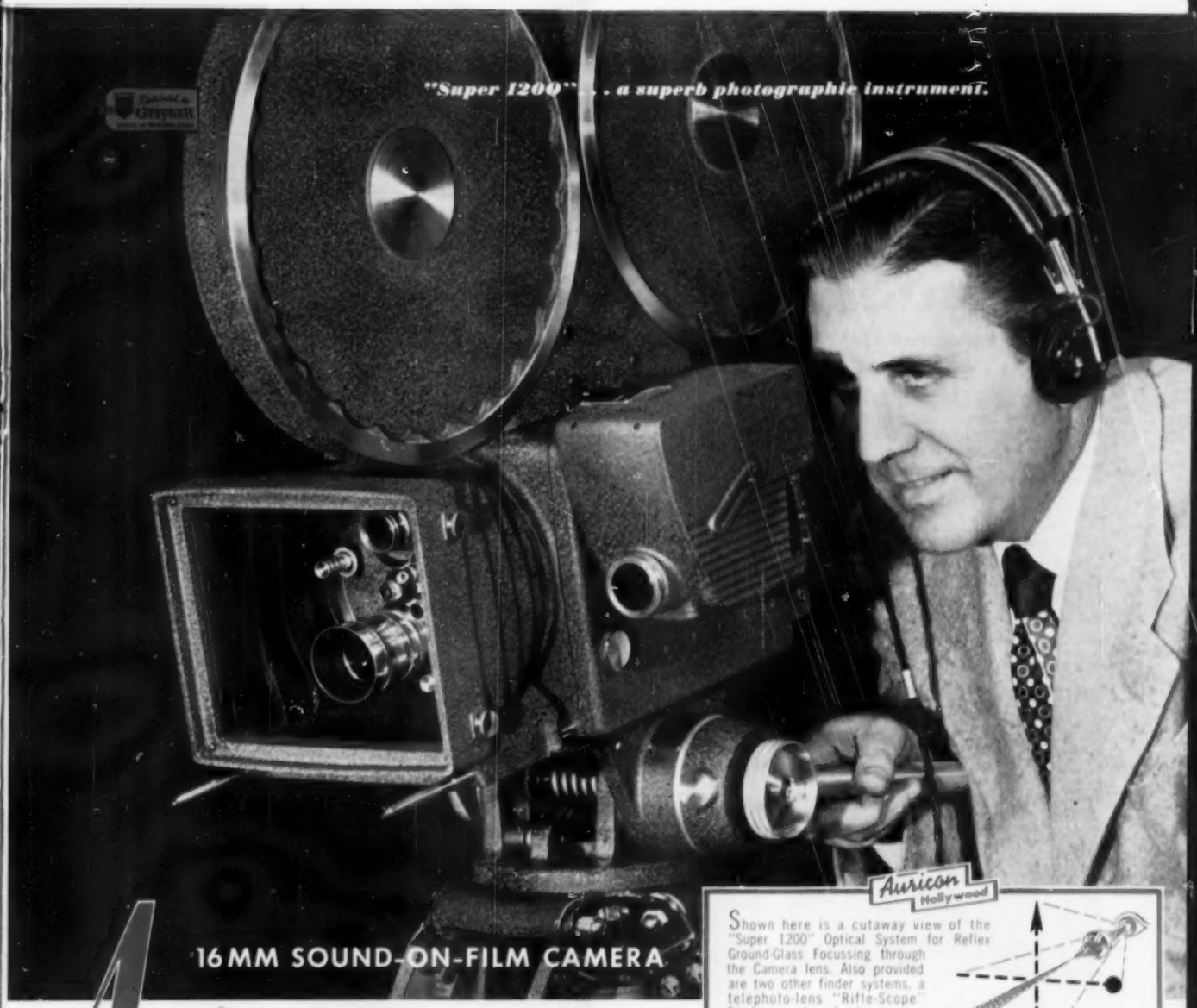

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with new Model "CM-74B" features . . .

- During picture exposure, your film runs through the New Auricon "Super 1200" Film-Gate with the light-sensitive film emulsion accurately positioned on jewel-hard Sapphire surfaces, an exclusive Berndt-Bach feature (U.S. Patent No. 2,506,765). This polished Sapphire Film-Gate is guaranteed frictionless and wear-proof for in-focus and scratch-free pictures, regardless of how much film you run through the camera!
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- 400 and 1200 ft. film Magazines available. Up to 33 minutes continuous filming.
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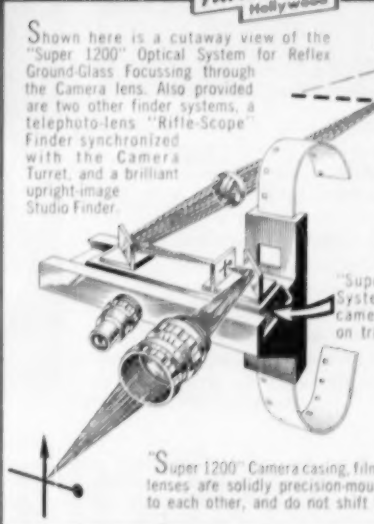
- Now priced from $4,652.15 complete for sound-on-film; $3,755.65 without sound; choice of "C" Mount lenses and Carrying Cases extra.
- Sold with a 30 day money-back Guarantee and One Year Service Guarantee; you must be satisfied. Write today for your free Auricon Catalog...

Auricon Hollywood

Shown here is a cutaway view of the "Super 1200" Optical System for Reflex Ground-Glass Focussing through the Camera lens. Also provided are two other finder systems, a telephoto-lens "Rifle-Scope" Finder synchronized with the Camera Turret, and a brilliant upright-image Studio Finder.



Dove-Tail Optical Carriage is only moving part of "Super 1200" Optical System. There is no camera-weight shift on tripod when moving from focus to film-shooting position.

"Super 1200" Camera casing, film gate and shooting lenses are solidly precision-mounted with relation to each other, and do not shift to focus or shoot.

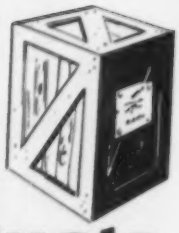
AURICON

BERNDT-BACH, INC.

6946 Romaine St., Hollywood 38, Calif.

The Auricon Hollywood Line

SOUND-ON-FILM EQUIPMENT SINCE 1931



new products

(and developments)

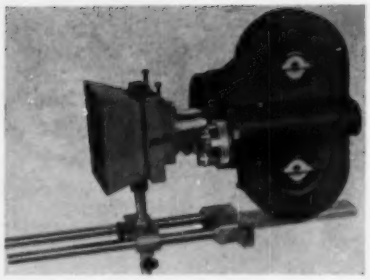
Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

A compact, industrial television system has been introduced by the Curtiss-Wright Corp., Wood-Ridge, N.J. This is one of a series of new Curtiss-Wright products in the fields of ultrasonics, electronics and plastics. The basic closed-circuit television system includes a camera equipped with the

small, but relatively sensitive, Resistron tube, a tripod, a remote control box, a control unit and one or more monitors. The camera itself is 8½ × 6 × 3½ in. The Resistron tube is reported as relatively insensitive to high temperatures and as having these other advantages: small enough so that standard lenses for 35 millimeter cameras can be used; great clarity of detail and dropping off only from 5 to 8% at the edges compared to losses up to 30% at the edges for older types of tubes.

National Tape Recording Catalog is a 32-page, paper-covered booklet, available at 50 cents a copy from the Dept. of Audio-Visual Instruction, National Educational Assn., 1201 Sixteenth St., N.W., Washington 6, D.C. Cataloged are 562 programs in 34 series of the best educational tapes. The catalog relates to the Re-recording Service at Tapes for Teaching, National Repository, Audio-Visual Center, Kent State Univ., Kent, Ohio. The service functions by re-recording on the customer's tape a 15-min. program for $0.50 and a 30-min. one for $1.00, at 7½ or 3¾ ips, single track.

A combination matte box and sunshade has been announced by National Cine Equipment, Inc., 209 W. 48 St., New York 36. Designed to fit 8mm and 16mm cameras it is for use with 2-in. square and 3-in. square glass or gelatine filters and accessories such as gauze holders and diffusion and effects filters. The matte box is made of aluminum castings. The base has both large and small tripod threads. The price is $44.95.



Whatever type of equipment you manufacture for Motion Pictures, your finest source for Film Sprockets is *LaVezzi* – We invite your inquiries.

SOUND-ON-FILM EQUIPMENT SINCE 1931

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Film Recording Engineer: Age 33, 4-yr experience motion-picture film recording, adjustment, operation and maintenance of these equipments: optical film recording; sprocket-driven and ¼-in. magnetic recording; and of kine recording. Also: sound transmission measurements; film density tests; film laboratory liaison. Heavy electronic development laboratory background; former AAF Electronics Officer; desires New York City location but will travel—Daniel A. Thaler, 158-30 90th St., Queens 14, N.Y.

Color and B & W Control. Interested in obtaining position with film company doing reversal or negative-positive color processing; age 32, have 14 years experience in still and motion pictures, color and B & W control, sensitometry, densitometry, chemical analysis; will locate anywhere; for full details write: H. N. Alexander, Box 12, Iowa City, Iowa.

Motion Picture Production or Teaching. Twelve years experience in production; Director of Photography, Small Homes Council, Univ. of Illinois, for last three years; M.A. in Physics, all class work toward Ph.D. in Mass Communications, starting research; First Class Radiotelephone Operator's license; Active Member, SMPTE; age 36; available Aug. 15. Write: John R. Gregory, 706 S. Anderson St., Urbana, Ill.

Sound Control Operator. Cuban, single, age 24, presently employed; capable of handling all phases of sound control and recording; wide experience in radio, television and 16- and 35mm film, plus master recording in Cuba for well-known trade-name and custom labels; would consider temporary or permanent position in U.S. or South America; complete résumé in English or Spanish sent on request; write to: P.E.M., c/o Carlos Castro, 10 No. 262, Apt. 8, Vedado, Habana, Cuba.

Positions Available

16mm Laboratory Personnel. General experience in laboratory work essential; good opportunity; send full particulars to: J. L. Pate, 3454 Midway Place, Decatur, Ga.

The Signal Corps Pictorial Center at 35-11 35th Avenue, Long Island City 1, N.Y., has an immediate need for applicants meeting the U.S. Civil Service Commission requirements for two positions listed below:

Photographer (M.P. Timer), GS-9: $5060/yr, male. Applicants must have had at least 5 yr of progressively responsible experience in motion-picture photographic laboratory work of which 2 yr must have been spent in motion-picture timing. The applicant's experience must demonstrate a thorough knowledge of all phases of positive and negative developing theory and a knowledge of densities, exposures, photographic solutions and the physical properties of various types of film utilized.

Photographer—Laboratory Technician (M.P. Color Sensitometrist): GS-7: $4205/yr, male. Applicants must have had 4 yr of experience in reading soundtrack and sensitometric strips by means of densitometers, including plotting, interpreting and recording data to evaluate factors involved such as gamma, speed, density and characteristics of printing machine, processing solutions and photographic emulsions.

B.S. or M.S. Physicist or Electrical Engineer with experience in photographic or magnetic sound recording. Will serve under Process Supervisor to investigate problems of photographic sound quality. Knowledge of film printing and processing equipment, recording methods, and film sensitometry desirable. Salary open. Send brief résumé incl. approx. salary requirements to E. E. Griffith, Technicolor Motion Picture Corp., 6311 Romaine St., Hollywood 38, Calif.

Film Inspectors: Permanent or summer positions open. Telephone or write — Mr. Kern Moyse or Miss Annabel Compton, Peerless Film Processing Corp., 165 W. 46 St., New York 36.

Require experienced 16mm motion picture laboratory technician for position as lab supervisor for growing motion-picture laboratory. Must be thoroughly experienced in control and processing color and B&W motion-picture films. Salary and percentage to man who can qualify. Send résumé and references to Western Cine Service, Inc., 114 E 8th Ave. Denver 3, Colo.

Membership Certificates (Active and Associate members only). Attractive hand-engrossed certificates, suitable for framing for display in offices or homes, may be obtained by writing to Society headquarters, at 55 West 42d St., New York 36, Price: $2.50.

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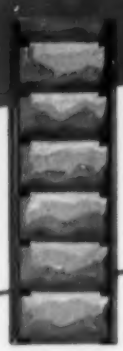

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For full information write, wire or phone **byron** *Studios and Laboratory*

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Contents — pages 264-280

News Columns

Papers Program—78th Convention..... 264
The 77th Convention..... 264
Section Reports..... 266
BOOK REVIEWS..... 267

Colour Cinematography, Third Edition, by Adrian Cornwell-Clyne, reviewed by W. T. Hanson, Jr.; *Progress in Photography*, published by Focal Press, reviewed by Lloyd E. Varden; *L'Ingénieur du Son en Radiodiffusion, Cinéma, Télévision*, by V. Jean-Louis, reviewed by Skipwith W. Athey; *Underwater Photography and Television*, by E. R. Cross, reviewed by George L. George; *Twenty Years of Cinema in Venice*, by Antonio Petrucci, reviewed by George L. George; *General Bibliography of Motion Pictures*, edited by Carl Vincent, Riccardo Redi and Franco Venturini, reviewed by George L. George; *Take Stock of Your Picture*, Van Praag Productions.

Current Literature..... 274
New Products..... 278
Employment Service..... 279

Advertisers

Berndt-Bach, Inc..... 277
Byron, Inc..... 280
Camera Equipment Co..... 270
Camera Mart..... 276
Cinema Engineering Co..... 274
Crown Gear Co..... 270
Florman & Babb..... 274
General Film Laboratories, Inc..... 273
Hollywood Film Co..... 275
Houston Fearless..... 272
Philip A. Hunt Co..... 266
LaVezzi Machine Works..... 278
Peerless Film Processing Corp..... 279
Photo-Sonics, Inc..... 271
Precision Film Laboratories, Inc..... 267
Professional Services..... 276
Reeves Soundcraft Corp..... 269
SMPTE..... 268
Westrex Corp..... 265

Meeting Calendar

Society of Photographic Engineers, May 18–21, U.S. Thayer Hotel, West Point, N.Y.
National Society of Professional Engineers, June 2–4, Hotel Bellevue-Stratford, Philadelphia, Pa.
SMPTE Central Section, June 13.
International Commission on Illumination, June 13–22, Zürich, Switzerland.
American Society of Mechanical Engineers, Semiannual Meeting, June 19–23, Hotel Statler, Boston, Mass.
American Rocket Society, Semiannual Meeting, June 19–23, Boston, Mass.
International Aeronautical Conference, joint mtg. of the British Aeronautical Society and the Institute of the Aeronautical Sciences, June 21–24, Los Angeles.
American Institute of Electrical Engineers, Summer General Meeting, June 27–July 1, New Ocean House, Swampscott, Mass.
Acoustical Society of America, June 30–July 2, Pennsylvania State College, State College, Pa.
Biological Photographic Association, Annual Meeting, Aug. 30–Sept. 2, Wisconsin Hotel, Milwaukee.
American Chemical Society, National Meeting, Sept. 11–16, Minneapolis, Minn.
Instrument Society of America, Sept. 12–16, Shrine Exposition Hall and Auditorium, Los Angeles.
National Electronics Conference, Oct. 3–5, Hotel Sherman, Chicago.
78th Semiannual Convention of the SMPTE, Oct. 3–7, Lake Placid Club, Essex County, N.Y.
American Institute of Electrical Engineers, Fall General Meeting, Oct. 3–7, Morrison Hotel, Chicago.
Photographic Society of America, Oct. 5–8, Sheraton-Plaza Hotel, Boston, Mass.
Optical Society of America, Oct. 6–8, Hotel Wm. Penn, Pittsburgh, Pa.
Audio Engineering Society, Oct. 12–16, Hotel New Yorker, New York.
American Standards Association, 37th Annual Meeting and Sixth Annual Conference on Standards, Oct. 24–26, Washington, D. C.
American Rocket Society, Nov. 13–18, Chicago.
American Society of Mechanical Engineers, National Meeting, Nov. 13–18, Hotels Congress, Hilton and Blackstone, Chicago.
American Institute of Chemical Engineers, Nov. 27–30, Hotel Statler, Detroit.
Acoustical Society of America, Dec. 15–17, Brown U., Providence, R. I.
79th Semiannual Convention of the SMPTE, Apr. 29–May 4, 1956, Hotel Statler, New York.
80th Semiannual Convention of the SMPTE, Oct. 7–12, 1956, Ambassador Hotel, Los Angeles.
81st Semiannual Convention of the SMPTE, Apr. 28–May 3, 1957, Shoreham Hotel, Washington, D.C.
82d Semiannual Convention of the SMPTE, Oct. 6–11, 1957, Hotel Statler, New York.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members were published in the April Journal.

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